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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING BOARD

HEARING

In the Matter of:

ENTERGY NUCLEAR VERMONT YANKEE, LLC

and

ENTERGY NUCLEAR OPERATIONS, INC. (Vermont Yankee Nuclear Power Station)

Docket No. 50-271-LR

ASLB No. 06-849-03-LR

Wednesday, July 23, 2008

Windham County Superior Court

7 Court Street

Newfane, Vermont

BEFORE:

ALEX S. KARLIN, Chair, Administrative Judge

RICHARD E. WARDWELL, Administrative Judge

WILLIAM REED, Administrative Judge

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P R O C E E D I N G S

8:31 A.M.

JUDGE KARLIN: Good morning. I'm Alex Karlin. This Board, Atomic Safety and Licensing Board, is now reconvening here on July 23rd in the matter of Entergy's application for a license renewal for its Vermont Yankee facility.

Today, we're going to turn to contention 3 in this matter, NEC and the State of Vermont have a contention which I will read here just for setting the stage. As I have it, "Entergy's license renewal application does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation." So that's the bare bones of the words of the contention as it's been admitted.

What I will do this morning is have the witnesses for this contention brought into the witness box and sworn in and then ask the attorneys for the parties to introduce the exhibits that are relevant and that they're presenting relevant to this contention so that's what I was planning to do.

Do either of my colleagues have anything they'd like to say on the outset this morning?

Anything from the counsel for the parties, procedurally or otherwise we need to talk about this morning?

So we're ready to go with contention 3. Great.

With that, perhaps I -- are all the witnesses seated? Dr. Hopenfeld, you'll probably need him over there as well.

And Ms. Carpentier will put up the name tags. This is helpful to us.

(Pause.)

Great, thank you. Could I ask you all to please rise and raise your right hand.

(The witnesses were sworn.)

Thank you. Please be seated.

Welcome. We are hopeful that this contention 3 might not take as long as contention 2 and if the thickness of the submissions by the parties is any indication, we may have some reason for hoping it will be shorter than contention 2. So welcome.

I guess I would now ask counsel for Entergy to have your witnesses introduce whatever exhibits you so have appropriately.

MR. LEWIS: Judge Karlin, Mr. Diaz will introduce the first one.

JUDGE KARLIN: Mr. Diaz, go ahead.

MR. TRAVIESCO-DIAZ: Thank you, Mr. Chairman.

Mr. Hopenfeld, will you please state your full name for the record?

MR. HOFFMAN: John R. Hoffman.

JUDGE KARLIN: Everyone needs to speak up as much as they can, please.

(Off the record.)

JUDGE KARLIN: Mr. Diaz, please continue.

MR. TRAVIESCO-DIAZ: Mr. Lukens, will you please state your full name for the record?

MR. LUKENS: Larry D. Lukens.

MR. TRAVIESCO-DIAZ: Mr. Hoffman and Mr. Lukens --

JUDGE KARLIN: Please also speak up so the people can hear you.

MR. TRAVIESCO-DIAZ: Mr. Hoffman and Mr. Lukens, do you have in front of you a document bearing the caption of this proceeding entitled "Joint Declaration of John R. Hoffman and Larry D. Lukens in NRC Contention 3"?

MR. LUKENS: Yes, I do.

MR. HOFFMAN: Yes.

MR. TRAVIESCO-DIAZ: Did you prepare this document for use in this proceeding?

MR. LUKENS: Yes.

MR. HOFFMAN: Yes.

MR. TRAVIESCO-DIAZ: Do you have any corrections to make to this testimony?

MR. LUKENS: Yes, I have.

MR. TRAVIESCO-DIAZ: Will you please state what those corrections are?

MR. LUKENS: In the testimony, answer 46, line 7 which is the last line of the table, change the number 47**(71.2 percent) to 48**(72.7).

MR. TRAVIESCO-DIAZ: And that's on page 25?

Please proceed.

MR. LUKENS: On page 25, answer 46, line 12 which is the first footnote, the first line of footnote **, change 47 previous indications were re-identified: 19 to 48 previous indications were previously identified; 27.

On page 25, line 14 which is the third line of that footnote, delete the word either between 2007 and the word do and page 25, line 15 which is the fourth line of that footnote, change the phrase conditions or because the previous indication was to conditions and nine previous indications were.

MR. TRAVIESCO-DIAZ: With those

corrections, is this testimony true and correct to the best of your knowledge?

MR. LUKENS: Yes.

MR. HOFFMAN: Yes.

MR. TRAVIESCO-DIAZ: Do you adopt it as your direct testimony in this proceeding?

MR. LUKENS: Yes.

MR. HOFFMAN: Yes.

MR. TRAVIESCO-DIAZ: Mr. Chairman, I move that the declaration of John R. Hoffman and Larry D. Lukens be admitted into evidence and bound to the record at this point.

JUDGE KARLIN: Any objections? Hearing none, it shall be admitted. Thank you.

(Whereupon, the declaration of John R. Hoffman and Larry D. Lukens were admitted into evidence.)

CORRECTED

May 9, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
Entergy Nuclear Vermont Yankee, LLC	)	Docket No. 50-271-LR
and Entergy Nuclear Operations, Inc.	)	ASLBP No. 06-849-03-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

JOINT DECLARATION OF JOHN R. HOFFMAN AND LARRY D. LUKENS ON NEC CONTENTION 3 – STEAM DRYER

John R. Hoffman and Larry D. Lukens state as follows under penalty of perjury:

1. We have prepared the attached "Testimony of John R. Hoffman and Larry D. Lukens on NEC Contention 3 – Steam Dryer" in the above captioned proceeding.

2. The factual statements and opinions we express in the cited testimony are true and correct to the best of our personal knowledge and belief.

3. We declare under penalty of perjury that the foregoing is true and correct.

Executed on May 9, 2008

/Original signed by John R. Hoffman/

John R. Hoffman

/Original signed by Larry D. Lukens/

Larry D. Lukens

Executed on May 9, 2008

Errata to Applicants' Testimony on NEC Contention 3

Witness	Citation (Page/Answer)	Correction
Lukens	25/A46 (line 7) (last line of table)	Change "47** (71.2%)" to "48** (72.7%)"
Lukens	25/A46 (line 12) (first line of footnote **)	Change "47 previous indications were re-identified; 19" to "48 previous indications were re-identified; 27"
Lukens	25/A46 (line 14) (third line of footnote **)	Delete "either" between "2007," and "due"
Lukens	25/A46 (line 15) (fourth line of footnote **)	Change "conditions or because the previous indication was" to "conditions, and 9 previous indications were"

NOTE: Corresponding changes are being made to exhibit E3-15.

May 9, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
Entergy Nuclear Vermont Yankee, LLC	)	Docket No. 50-271-LR
and Entergy Nuclear Operations, Inc.	)	ASLBP No. 06-849-03-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

TESTIMONY OF JOHN R. HOFFMAN AND LARRY D. LUKENS ON NEC CONTENTION 3 – STEAM DRYER

I. WITNESS BACKGROUND

John R. Hoffman ("JRH")

Q1. Please state your full name.

A1. (JRH) My name is John R. Hoffman.

Q2. By whom are you employed and what is your position?

A2. (JRH) I am an independent consultant. Prior to September 2006, I was employed by Entergy Nuclear Operations, Inc. ("ENO") and had, among other responsibilities, that of Project Manager for the License Renewal Project at the Vermont Yankee Nuclear Power Station ("VY"). I retired from ENO's employment in September 2006.

Q3. Please summarize your educational and professional qualifications.

A3. (JRH) My professional and educational experience is described in the *curriculum vitae* attached to this testimony as Exhibit E3-02.

Briefly summarized, I have over 37 years of nuclear power engineering experience. I received a B.E. Degree in Mechanical Engineering from the Cooper Union for the Advancement of Science and Art in 1967, an M.S. Degree in Nuclear Engineering from the University of Lowell in 1977, and an M.S. Degree in Applied Management from Lesley College in 1985. I am a Registered Professional Engineer in the States of Massachusetts and Vermont. I have been associated with VY since 1971.

Q4. What is the purpose of your testimony?

A4. (JRH) The purpose of my testimony is to address, on behalf of Entergy Nuclear Vermont Yankee, LLC and ENO (collectively "Entergy"), Contention 3 submitted by the New England Coalition ("NEC") in this proceeding. As admitted by the Atomic Safety and Licensing Board ("Board"), NEC Contention 3 reads:

> Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation.

Memorandum and Order (Ruling on Standing, Contentions, Hearing Procedures, State Statutory Claim, and Contention Adoption), LBP-06-20, 64 N.R.C. 131, 187 (2006). The scope of NEC Contention 3 has been subsequently narrowed by the Board, which has ruled that two issues remain to be adjudicated with respect to the contention:

> 1. Whether Entergy has established sound evaluation and implementation procedures to assure that the integrity of the steam dryer is not jeopardized. Specifically, NEC contends that the status of the dryer cracks must be continuously monitored and assessed by a competent engineer. While Entergy has established that it will continuously monitor plant parameters indicative of steam dryer cracking, it has not

provided information on its assessment program for the monitoring data or the qualifications of the personnel evaluating this information.

2. Whether a steam dryer aging management program that does not provide a means to estimate and predict stress loads on the dryer during operation for comparison to established fatigue limits is valid.

Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 3) (September 11, 2007), slip op. at 11-12.

Q5. What has been your role at VY as it relates to NEC Contention 3?

A5. (JRH) In the License Renewal Project at VY, my team was responsible for the development of the proposed program to manage the aging of the VY steam dryer during the renewed license operating period. As Project Manager, I had the responsibility to ensure that all aspects of the license renewal application, including the steam dryer aging management program, were properly developed and were reviewed by the respective subject matter experts at VY.

LARRY D. LUKENS ("LDL")

Q6. Please state your full name.

A6. (LDL) My name is Larry D. Lukens.

Q7. By whom are you employed and what is your position?

A7. (LDL) I am an independent consultant. Prior to July 2007, I was employed by ENO and had, among other responsibilities, that of Supervisor, Code Programs at VY. In that position, my responsibilities entailed ensuring that the activities required by industry codes, particularly those issued by the American Society of Mechanical Engineers ("ASME"), that are applicable to VY and are the responsibility of Engineering are completed, evaluated, dispositioned, and documented. The required activities included, for example, those described by the ASME Operation and Maintenance Code for testing pumps and valves; the ASME Boiler & Pressure Vessel ("BPV") Code for inservice inspection ("ISI"), including containment inservice inspections; the primary containment integrity monitoring program described by 10 C.F.R.50, Appendix J; and the reactor vessel and internals management and monitoring program under the Electric Power Research Institute ("EPRI") BWR Vessel & Internals Program (BWRVIP), an industry initiative implemented with the concurrence and participation of the NRC. I was directly involved with the license renewal audits and inspections of Code Programs activities including the inservice testing ("IST"), ISI, Containment ISI, Appendix J, and BWRVIP, and with the Fire Protection programs, and I approved the VY license renewal commitments relating to these programs. I retired from ENO's employment in July 2007.

Q8. Please summarize your educational and professional qualifications.

A8. (LDL) My professional and educational experience is summarized in the *curriculum vitae* attached to this testimony as Exhibit E3-03. Briefly summarized, I received a B.S. Degree in Nuclear Engineering from the University of Wisconsin, Madison, in 1978. I have over 38 years of nuclear power work experience. My relevant experience includes being a qualified reactor operator in the U.S. Navy and an NRC licensed operator at the University of Wisconsin, and nearly 10 years of service as Program Manager for ASME Section XI inservice testing, inservice pressure testing, and containment leak rate testing at an operating nuclear power plant. I have been associated with VY since 2002.

Q9. What is the purpose of your testimony?

A9. (LDL) The purpose of my testimony is to address those aspects of NEC Contention 3 that relate to the steam dryer inspections that have been conducted to date and those to be performed during the period of plant operations after renewal of the VY license.

Q10. What has been your role at VY as it relates to NEC Contention 3?

A10. (LDL) As Supervisor of Code Programs, I was responsible for ensuring the proper completion and evaluation of the steam dryer inspections conducted during the 2005 and 2007 refueling outages. I was also responsible for overseeing the license renewal aging management program as it applied to the steam dryer.

II. OVERVIEW

A. Background

Q11. Would you please describe briefly the VY steam dryer?

A11. (JRH) In a boiling water reactor ("BWR"), the steam dryer is a stainless steel component whose function is to remove moisture from the steam before it leaves the reactor. The dryer is installed in the reactor vessel above the steam separator assembly and is supported by brackets welded to the inside of the vessel wall below the steam outlet nozzles.

During plant operations, wet steam flows upward and outward through the dryer. Moisture is removed by impinging on the dryer vanes and flows down through drains to the reactor water in the downcomer annulus below the steam separators. The VY steam dryer is a non-safety-related, non-Seismic Category I component. Although the steam dryer is not a safety-related component, the assembly is designed to withstand design basis events without the generation of loose parts and the dryer is designed to maintain its structural integrity through all plant operating conditions.

Q12. Have concerns about steam dryer performance arisen in the nuclear industry?

A12. (JRH) Yes. In 2002, steam dryer cracking and damage to components and supports for the main steam and feedwater lines were observed at the Quad Cities Unit 2 nuclear power plant. It was determined that loose parts shed by the dryer due to flow-induced vibration that caused metal fatigue failure of the dryer had damaged the supports. The Quad Cities experience raised concern in the industry about the need to assure the physical integrity of steam dryers.

Q13. Did those concerns relate to the performance of the dryer or to the potential effects of a steam dryer failure?

A13. (JRH) The latter. The steam dryer does not perform any safety functions and is not required to prevent or mitigate the consequences of accidents. Therefore, the condition of the steam dryer is only of concern to the extent that a failure of the dryer could have adverse impact on safety-related equipment.

Q14. What do you mean by failure?

A14. (JRH) A loss of physical integrity of the dryer such that loose dryer sections or parts are released to the reactor steam space (that is, the space in the reactor where steam is confined above the water) and potentially migrate to other components.

Q15. Does the formation of cracks in the dryer's surface constitute a failure of the dryer?

A15. (JRH) No. However, the existence of those cracks needs to be identified and evaluated before the cracks progress to the point where they could cause a loss of physical integrity of the dryer, resulting in loose parts.

Q16. Were actions taken at VY in response to the Quad Cities 2 event?

A16. (JRH) Yes. Quad Cities Unit 2 had implemented a power uprate analogous to the extended power uprate ("EPU") that Entergy was planning to implement at VY. Accordingly, Entergy substantially modified the steam dryer at VY during the Spring 2004 refueling outage to improve its capability to withstand the higher flow induced vibration loadings that could result from operation of the plant at EPU levels. The modifications, intended to increase the structural strength of the dryer, are described in Attachment 2 to Supplement 8 (dated July 2, 2004) to the EPU Application, ADAMS Accession No. ML042090103, Exhibit E3-04 hereto. In addition, VY instituted a program of dryer monitoring and inspections to provide assurance that the flow-induced loadings under normal operation at EPU levels did not result in the formation or propagation of cracks on the dryer. The program is described in Attachment 6 to Supplement 33 (dated September 14, 2005) to the EPU Application, ADAMS Accession No. ML052650122, Exhibit E3-05. The program was reviewed and approved by the NRC and included as a license condition as part of the power uprate license amendment issued on March 2, 2006.

Q17. Has a dryer monitoring and inspection program been implemented at VY since the plant uprate was accomplished?

A17. (JRH) Yes. As power was increased from the original licensed power level to full EPU conditions, there was continuous monitoring of plant parameters indicative of dryer performance. The program included measurement at least once per week of moisture carryover and periodic measurement of main steam line pressure. Following completion of EPU power ascension testing, moisture carryover measurements continue to be made periodically, and other plant operational parameters that would be symptomatic of loss of steam dryer structural integrity (main steam line flow, reactor vessel water level, steam dome pressure) continue to be monitored and their values trended. This monitoring program will continue to be implemented during the period of extended operation after renewal of the VY license.

In addition, the steam dryer was inspected during plant refueling outages in the Fall of 2005 (before completion of the EPU) and Spring of 2007 (after one year of operation at EPU power levels). The dryer is scheduled to be inspected again during the refueling outages in the Fall of 2008 and the Spring of 2010, with a partial inspection scheduled for the Fall of 2011. Inspections will continue in the license renewal period starting with the first refueling after March 2012. The inspections are conducted in accordance with the recommendations of General Electric's Service Information Letter ("SIL") No. 644, Revision 2 (August 30, 2006), ("GE-SIL-644"), Exhibit E3-09 hereto, which is an updated version of the GE-SIL-644 Revision 1 document referenced in the License Renewal Application (Exhibit E3-06). Again, this inspection program will continue during the period of extended operation.

B. Issues Raised By Contention

Q18. What is your understanding of the technical issues raised by NEC Contention 3?

A18. (JRH) NEC Contention 3 raises two issues regarding the adequacy of the program, in VY's License Renewal Application, to monitor and manage aging of the steam dryer during the period of extended operation. Those issues are: (1) Whether Entergy has established sound inspection and evaluation procedures to assure that the physical integrity of the steam dryer is not jeopardized; and (2)

Whether a steam dryer aging management program that does not provide a means to estimate and predict stress loads on the dryer during operation for comparison to established fatigue limits is valid.

Q19. Do you agree with the assertion in NEC Contention 3 that the License Renewal Application is deficient in these two respects?

A19. (JRH, LDL) No.

Q20. Will you please summarize the basis for your disagreement?

A20. (JRH, LDL) NEC's Contention 3 claims that the status of the dryer cracks must be continuously monitored and assessed by a competent engineer and suggests that Entergy will not carry out these activities during the license renewal period. However, Entergy's proposed steam dryer aging management program includes continuous monitoring of the previously mentioned plant parameters for which a departure from normal range of values would be symptomatic of significant steam dryer cracking, assessment of the monitoring data, and evaluation of the significance of changes in the data by several levels of qualified personnel. The on-line monitoring is augmented by the refueling outage inspections discussed above. Thus, there is no deficiency in the proposed program to monitor and manage dryer performance during the license renewal period.

With respect to the alleged need to provide a means to estimate and predict stress loads on the dryer during operation for comparison to established fatigue limits, no such a need exists because the monitoring program, supplemented by the periodic dryer inspections during refueling outages, is sufficient to diagnose whether significant dryer cracking has occurred before such cracking results in dryer failure. The same approach is used in other aspects of fatigue monitoring in the reactor system components. Those fatigue monitoring programs do not require the estimation of actual loads on the components.

Thus, the inspection and monitoring program for the steam dryer is consistent with the methodology and rigor applicable to safety-related components in other inspection programs. Real time estimation of stresses imparted on the dryer during plant operation is unnecessary to assure its integrity.

III. DESCRIPTION OF VY'S STEAM DRYER AGING MANAGEMENT PROGRAM

A. Programmatic Basis for the Proposed Aging Management Program for the VY Steam Dryer

Q21. Please describe the aging management program for the steam dryer included in the VY License Renewal Application.

A21. (JRH) In its License Renewal Application, Entergy addresses aging management of the VY steam dryer as follows:

> Cracking due to flow-induced vibration in the stainless steel steam dryers is managed by the BWR Vessel Internals Program. The BWR Vessel Internals Program currently incorporates the guidance of GE-SIL-644, Revision 1. VYNPS will evaluate BWRVIP-139 once it is approved by the staff and either include its recommendations in the VYNPS BWR Vessel Internals Program or inform the staff of VYNPS's exceptions to that document.

License Renewal Application, § 3.1.2.2.11 "Cracking due to Flow-Induced Vibration." GE-SIL-644 recommends that BWR licensees institute a program for the long term monitoring and inspection of their steam dryers. It provides detailed inspection and monitoring guidelines (see GE-SIL-644 Rev. 1, Exhibit E3-06 hereto, Appendices C and D).

Q22. Does the proposed monitoring and inspection program for the VY steam dryer conform to the recommendations in SIL-644?

A22. (JRH, LDL) Yes.

Q23. Does the proposed monitoring and inspection program for the VY steam dryer conform to the recommendations in the GALL Report (NUREG-1801)?

A23. (JRH, LDL) Yes. The GALL Report calls for a plant-specific aging management program to be evaluated. See Exhibit E3-08. In its Safety Evaluation Report, the NRC Staff concluded that Entergy's commitment to implement BWRVIP-139, if approved by the NRC Staff prior to the period of extended operation, will result in the aging of the steam dryer to be adequately managed, as recommended by the GALL Report. SER at 3-175.

B. Dryer Monitoring Program

Q24. Please describe the proposed steam dryer monitoring program to be implemented during the period of extended plant operation following renewal of the VY license.

A24. (JRH) The status of the steam dryer is assessed continuously by the plant operators and VY's technical staff through the monitoring of certain plant parameters. VY Off-Normal Procedure ON-3178 (Exhibit E3-07 hereto) alerts the operators that any of the following events could be indicative of significant dryer damage: (a) sudden drop in main steam line flow >5%; (b) >3 inch difference in reactor vessel water level instruments; and (c) sudden drop in steam dome pressure >2 psig. In addition, periodic measurements of moisture carryover are performed, and changes in moisture carryover are evaluated in accordance with the requirements of GE-SIL-644 to determine whether significant cracking has occurred. The monitoring program now in place will continue for the entire license renewal period.

In addition to implementing its docketed commitment to GE-SIL-644, Revision 1, VY has adopted the additional recommendations in GE-SIL-644 Revision 2 (Exhibit E3-09 hereto) for its BWRVIP Program. The purpose of Revision 2 to GE-SIL-644 is to update the monitoring guidance in Appendix D. These updates reinforce the need for continuous monitoring of plant parameters.

Q25. How would this monitoring detect cracking?

A25. (JRH) Abnormal values of the monitored plant parameters would indicate that the steam leaving the reactor has a high moisture content, which in turn could indicate that steam is escaping through a crack in the dryer. See Exhibit E3-06, Appendix D. Such escape would be symptomatic of a significant crack that might result in loss of physical integrity of the dryer.

Q26. What additional recommendations are contained in Revision 2 to GE-SIL-644?

A26. (LDL) Appendix D of GE-SIL-644, "Monitoring Guidelines," which provides guidelines for monitoring moisture carryover and other parameters that may be indicative of dryer damage, has been expanded from three pages in Rev. 1 to six pages in Rev. 2, and the guidance it contains is commensurately more specific and precise. The changes to Appendix D provide much more detailed guidance for plant personnel in effectively monitoring moisture carryover as an indicator of dryer cracking.

Q27. How is the monitoring of moisture carryover to be performed?

A27. (JRH) Moisture carryover is measured by plant chemistry personnel using procedure OP-0631 Appendix F (Exhibit E3-10). If moisture carryover is determined to be greater than the limit stated in the procedure (currently 0.19%), the procedure requires that a Condition Report ("CR") be written, the Shift Manager notified, and actions taken in accordance with Off-Normal Procedure ON-3178.

Q28. How and by whom is the significance of the measurements of moisture carryover to be assessed?

A28. (JRH) The Shift Manager performs the initial assessment of the data. If the moisture carryover is in the range of 0.19% to 0.35%, Off- Normal Procedure ON-3178 requires that plant management and engineering (the General Manager, Operations Management, Systems Engineering, Reactor Engineering, and Design Engineering Mechanical) be informed. Additionally, the Operational Decision Making Initiative ("ODMI") process is to be initiated. The ODMI process is used whenever an emergent plant issue comes up that requires an especially methodical, systematic, conservative decision making process affecting station operation. The ODMI procedure provides the structure and process for these decisions and helps to ensure that senior management oversight, vendor expertise, fleet expertise, industry experience and any additional resources are applied in an effective, efficient manner. In addition, an engineering evaluation in accordance with EN-OP-104 "Operability Determinations" is to be performed. If moisture carryover exceeds 0.35% station management is notified and operability evaluation is requested. If the results of the evaluation do not support continued plant operation, the reactor is brought to hot shutdown. In either case, experienced qualified engineering personnel will determine the significance of the abnormal moisture carryover measurement.

Q29. How is the monitoring of main steam line flow, reactor vessel water level, and steam dome pressure performed?

A29. (JRH) Data on these parameters are available continuously in the control room, and the control room operators monitor and record these data.

Q30. What happens if abnormal values of main steam line flow, reactor vessel water level, and steam dome pressure are measured?

A30. (JRH) If any of the action levels for main steam line flow, reactor vessel water level, and steam dome pressure are reached (as described in Procedure ON-3178), the procedure requires that a moisture carryover measurement be performed by the plant's Chemistry Department. The results of that measurement dictate the required response, as described above.

Q31. What are the qualifications of the personnel assessing the significance of the moisture carryover and other measured parameters?

A31. (JRH) The personnel involved in determining the significance of the moisture carryover and other measured parameters are required to be qualified in the application of the operability determination procedure EN-OP-0104 (Exhibit E3-11 hereto). A prerequisite for procedure qualification is the requirement that the individual(s) be enrolled in the Engineering Support Personnel training program and that their capability to perform independent engineering work be assessed by their supervisor. This is part of Entergy's Engineering Support Personnel training program, which includes an annual assessment of individual training needs by the engineer and his supervisor. Thus, if an engineer or his supervisor feels the engineer needs additional training to maintain or enhance his level of expertise, that training is incorporated into the performance goals for the year. Thus, by virtue of their training, the members of the VY technical staff are qualified to make a decision as to the significance of moisture carryover measurements.

Q32. Will the plant continue to operate if values of moisture carryover or the other parameters indicate that steam dryer cracking may have occurred?

A32. (JRH) No. As stated in Procedure ON-3178, "IF the engineering evaluation of plant data confirms that steam dryer damage may have occurred, THEN: initiate a plant shutdown per OP 0105, place the plant in a cold shutdown condition within 24 hours, evaluate reportability per AP 0156."

Q33. Will the measurements of moisture carryover, main steam line flow, reactor vessel water level, and steam dome pressure enable Entergy to determine whether a dryer crack is about to form?

A33. (JRH) No. The purpose of these measurements is to provide early warning to the plant personnel that a crack may have developed so that appropriate, timely action may be taken before undesirable effects ensue as a result of the crack.

Q34. Why is it acceptable for the plant personnel not to know of the likely formation of steam dryer cracks in advance of their actual occurrence?

A34. (JRH) There is no technology that will predict when a crack will initiate. Crack formation can be caused by one of three mechanisms: stress relief, fatigue, or intergranular stress corrosion. These mechanisms are not unique to the steam dryer.

Stress relief cracks typically form early in a component life and tend to arrest once the locked-in fabrication stresses are relieved through crack formation. Fatigue cracks can be experienced by components subjected to cyclic stresses of sufficient magnitude and duration. Stress corrosion cracks can occur when a component of a given material is subjected to a particular combination of stresses and environmental conditions.

Inspection and monitoring programs are developed and implemented to ensure that any cracks developing as a result of one of these mechanisms are detected before they develop to a size that would be of concern.

C. Dryer Inspection Program

Q35. Please describe the guidance that will be used in performing the steam dryer monitoring program during the period of extended plant operation following renewal of the VY license.

A35. (LDL) Because VY has a BWR-3 steam dryer, the details of the visual inspection program to be implemented are set forth in the section of GE-SIL-644 devoted to such dryers, which is Appendix C, pp. 15-16. The dryer inspections are to be performed in accordance with the VY BWRVIP Program Plan. VY-RPT-06-00006 (Exhibit E3-12) and GE-SIL-644, Revision 1.

The dryer examinations consist of VT-1 and VT-3 examinations of accessible internal and external welds and plates in the steam dryer potentially susceptible to crack formation. VT-1 and VT-3 examinations are defined by ASME Boiler & Pressure Vessel ("BPV") Code Section XI, and the non-destructive examination technicians who perform and review these examinations are qualified in accordance with ASME BPV Section XI.

Q36. Please describe the VT-1 and VT-3 examinations.

A36. (LDL) Briefly, these examinations can be described as follows: A VT-1 visual examination under BWRVIP standards (such as the steam dryer inspections) is one capable of achieving a resolution to discern a 0.044 inch (slightly over 1/32 inch) high lower case character with no ascender or descender strokes (e.g., an a, c, e, or o) on an 18% neutral gray card. A VT-1 examination determines the condition of a part, component or surface, including cracks, wear, corrosion, erosion, or physical damage on the surfaces of the part or component.

A VT-3 visual examination is intended to determine the general mechanical and structural condition of components, such as the verification of clearances, settings, physical displacements, loose or missing parts, debris, corrosion, wear, erosion, or the loss of integrity at bolted or welded connections. A VT-3 examination under the BWRVIP standards requires character recognition of 0.105 inch characters on an 18% neutral gray card, similar to the VT-1 demonstration.

The VT-1 and VT-3 steam dryer examinations at VY also include the steam dryer hold-down bolts, the tie bars, the manway cover, the lifting eye assemblies, and the lifting eye attachment welds.

In addition, other examinations have been added to the scope of dryer inspections as a result of industry experience. For example, the Spring 2007 examination scope included VT-1 examination of all four steam dryer support lugs, which are reactor vessel wall integral attachments. Although not specifically identified as being within the required scope of steam dryer inspections, certain U.S. BWRs have experienced accelerated wear on these lugs. Therefore, VY chose to inspect the support lugs as a good practice addition to the inspection program. No accelerated wear was noted on these lugs at VY.

Steam dryer examinations at VY are performed using high resolution color cameras and are recorded directly to digital video disks ("DVDs") for review and evaluation. A "resolution demonstration" is performed by aiming the camera at a "Sensitivity Resolution Contrast Standard" and verifying that the lighting and the equipment at actual test conditions meets the 0.044 inch resolution requirement for the examination being performed.

The resolution demonstration is also recorded on DVDs for future review. Therefore, the technicians and structural engineers reviewing the inspection results see exactly the same surface conditions that the inspecting technician saw during the examination.

Q37. How often are the steam dryer inspections conducted?

A37. (LDL) The steam dryer is inspected during each scheduled refueling outage, approximately every 18 months.

Q38. Who performs the steam dryer inspections?

A38. (LDL) The inspections are performed by qualified non-destructive examination ("NDE") inspection personnel, using qualified NDE techniques appropriate for BWR steam dryer inspections. Because of the large number of individual examinations to be performed during a refueling outage, this work is typically contracted out to qualified vendors, including the reactor supplier (General Electric).

Q39. What are the training and qualification requirements applicable to Level II NDE personnel?

A39. (LDL) A Level II NDE technician is qualified in accordance with the requirements for Level II NDE technicians in the ASME BPV Code Section XI. This qualification includes documented training that must be given by a Level III NDE technician who is qualified in the examination of interest: a visual acuity and color acuity test; and documented NDE experience under the direct oversight and supervision of a qualified NDE Level III technician. Qualifications to perform VT-1 and VT-3 examinations are achieved separately and are subject to separate, documented qualification processes. The NDE technician must renew these qualifications; must re-take the vision tests: and must document examination experience as part of ongoing proficiency maintenance. The specific requirements for this qualification and requalification process are found in ASME BPV Code Section XI.

Q40. Who evaluates the dryer inspection data?

A40. (LDL) The inspection data are reviewed by qualified Level III NDE personnel and are subject to final acceptance by Entergy Level III NDE personnel. The ASME BPV Code requires that the examinations be performed by a qualified NDE technician and that the examinations and their results be reviewed and approved by a qualified NDE technician. VY typically contracts both the Level II and Level III services for reactor vessel and internals examinations, including the steam dryer examinations. As an additional quality step, Vermont Yankee requires that these examinations also be reviewed by an Entergy Level III NDE technician. The Entergy Level III review and approval is required to be completed on 100% of the steam dryer examinations prior to its return to service.

Q41. What are the training and qualification requirements applicable to Level III NDE personnel?

A41. (LDL) Similar to the Level II NDE technician, a Level III NDE technician is qualified in accordance with the requirements for Level III NDE technicians in the ASME BPV Code Section XI. This qualification includes documented training that must be conducted by a Level III NDE technician who is qualified in the examination of interest; a visual acuity and color acuity test; and documented NDE experience under the direct oversight and supervision of a qualified NDE Level III. The principal difference between a Level II and a Level III technician is the amount of formal training and the number of hours of documented examination experience. The NDE technician (both Level II and Level III) must renew these qualifications; must re-take the vision tests; and must document examination experience as part of ongoing proficiency maintenance. The specific requirements for this qualification and requalification process are found in ASME BPV Section XI.

Q42. How does Entergy assess the significance of any detected evidence of potential dryer cracks?

A42. (LDL) All detected indications are evaluated by qualified structural engineers, who are experienced with BWR steam dryer crack evaluation. Typically, these indications are evaluated by engineers who are on the staff of the reactor vendor, and the evaluations and conclusions are reviewed and accepted by qualified Entergy structural engineers.

Q43. What are indications?

A43. (LDL) Indications are surface discontinuities. An indication is an imperfection or unintentional discontinuity that is detected by nondestructive examination. Not all indications are cracks. Sometimes an indication is a shadow that results from a peculiarity of the surface condition or illumination. An indication is classified as *recordable* or relevant if it is visible to the resolution of the examination technique. For example, any apparent surface imperfection identified during a VT-1 would be considered recordable or relevant, and any surface imperfection that is 0.044 inch or greater would be visible. All recordable indications found by the Level II NDE technician who performs the examination are identified and documented in the corrective action program. All recordable indications that are confirmed by the Level III NDE technician are evaluated by Engineering to determine whether or not they are *rejectable*. Rejectable indications are those that must be repaired prior to restarting the plant. Repair of rejectable indications is an ASME BPV Code Section XI requirement.

Q44. How are recordable steam dryer indications evaluated?

A44. (LDL) Recordable indications in the steam dryer are evaluated to determine whether the indication represents a potential crack or just a surface imperfection. As stated previously, cracks in BWR steam dryers are one of the following three types: fatigue cracks; intergranular stress corrosion cracks ("IGSCC"), and stress relief cracks. Cracks in the steam dryer are typically stress relief cracks and self-arrest when the stress is relieved.

In evaluating a VT- examination, it is possible to determine from the video recording of the examination whether an indication has the characteristics of a fatigue crack, an IGSCC crack, or a stress relief crack, based on its location and physical characteristics. IGSCC cracks arrest when the initiating condition (a combination of stress and environment) is mitigated. IGSCC cracks typically appear in the heat-affected zone ("HAZ") of a weld. Stress relief cracks may occur at any location with sufficient residual manufacturing stress.

If the characteristics of a particular indication do not rule out fatigue, the indication is typically classified as a potential fatigue indication. Subsequent examinations determine whether the indication is growing. A fatigue crack would be expected to grow; a crack that does not grow would not show the characteristic behavior of fatigue and would not be of concern.

An important aspect of visual examinations is that all recordable (relevant) indications are examined in subsequent cycles to determine whether any of the indications is an active crack. All recordable indications are reinspected at each refueling outage until at least two consecutive inspections show no growth.

Q45. What provides assurance that indications will not become cracks that propagate to the point of causing a dryer failure during the period between inspections?

A45. (LDL) Part of the indication evaluation is the determination of the potential for growth during the following eighteen month operating cycle until the next refueling inspection. IGSCC cracks are typically short and tight (on the order of 1 inch long and show no measurable width) and typically do not grow in subsequent cycles, since protection by hydrogen injection and noble metal application produces an environment that resists IGSCC propagation.

Stress relief cracks may be larger and may show measurable width. After the residual stress is relieved, a stress relief crack is arrested. Vermont Yankee has not identified any steam dryer cracks that are consistent with fatigue, and this conclusion is supported by the fact that the identified indications have not grown during subsequent operating cycles.

Q46. How many steam dryer inspections have been conducted at VY and what have been their results?

A46. (LDL) The VY steam dryer has been inspected as part of the BWRVIP inspection program since VY's adoption of the BWRVIP guidelines. The first dryer inspections were conducted in the Spring 1998 refueling outage. VT-3 examinations of the dryer and steam separator were performed, and five indications were identified on tack welds. The Fall 1999 refueling outage reexamined the five tack welds where indications had been identified in the previous outage. The Fall 2002 outage included VT-1 and VT-3 examinations of steam dryer cover plates and welds.

Most recently, during the Spring 2004 refueling outage, in preparation for EPU, the dryer received a baseline VT-1 inspection of all accessible areas deemed potentially susceptible to crack formation. These examinations comprised 287 weld and plate examinations. See Exhibit E3-13, a summary that I prepared of the 2004 inspections and their results based on my review of the dryer inspection results reported by General Electric, which conducted the inspections. A total of 20 indications were identified, of which 2 were weld-repaired, and 18 were determined acceptable to use as-is. Physical modifications to the VY steam dryer were made in 2004 to increase the dryer's resistance to vibration loadings.

The steam dryer inspections performed during the Fall 2005 outage examined all high-stress areas, as identified in GE-SIL-644. In addition, all areas that had been repaired or modified in the Spring 2004 outage were reinspected, as well as those indications that were found and evaluated to be acceptable for use as-is during the Spring 2004 outage. See Exhibit E3-14, a summary that I prepared of the 2005 inspections and their results based on my review of the dryer inspection results reported by AREVA, which conducted the inspections. These examinations comprised 113 internal and external weld examinations. A total of 66 indications were identified, including 20 previously identified indications and repaired areas from 2004, all of which were found acceptable for use as-is. The increase in identified VT-1 indications was due to increased resolution of the VT-1 examinations. Therefore, several indications not previously visible were identified in the 2005 examinations, even though the number of examinations was less than in 2004.

During the Spring 2007 outage, all accessible susceptible areas of the steam dryer were inspected, consistent with the guidance in SIL-644, Revision 1. See Exhibit E3-15, a summary that I prepared of the 2007 inspections and their results based on my review of the dryer inspection results reported by General Electric, which conducted the inspections. The previously repaired areas, the identified high stress areas, as well as those indications that were previously found and evaluated to be acceptable for use as-is were also examined. The examination included susceptible accessible internal and external welds and plates. A total of approximately 448 individually identified steam dryer examinations were performed. VY specified that the examination quality in 2007 must be sufficient to identify all indications found in the 2005 examinations. The 0.044 inch character resolution was required and documented on the examination DVDs.

A total of 66 indications were recorded, including 47 of those identified in 2005 and 19 previously unidentified indications. These 19 previously unidentified indications were the result of the increased examination scope in 2007 compared to that in 2005 (448 in 2007 and 94 in 2005), and the fact that all accessible susceptible areas of the steam dryer had been subjected to the improved resolution VT-1 as a result of the 2005 experience. All 75 of the indications identified in 2007 were accepted for use as-is.

In the years between 2004 and 2007, certain additional areas potentially susceptible to crack formation were identified beyond those identified as susceptible as of 2004. Therefore, the total scope of the 2007 dryer inspection (463 examinations) was larger than that of the 2004 inspection (287 examinations) by 176 examinations.

The number of examinations performed in the dryer inspections conducted since 2004 and the number of indications found in each can be summarized as follows (See Exhibits E3-13, 14 and 15):

Year of Dryer Exam	Total Dryer Exams	Recorded Indications	Rejected Indications (Repaired)	Indications Dispositioned Use As-Is	Previously Recorded Indications Re-Identified*
2004	287	20	2	18	N/A
2005	113	66*	0	66	20 (100%)
2007	463	66	0	66	4~~1~~ 8** (~~71.2~~ 72.7%)

*The 66 recorded indications in 2005 included 18 relevant indications reported in 2004 plus the repaired areas on the two rejected indications from 2004. Therefore, there were 46 newly identified relevant indications.

**In 2007, ~~47~~ 8 previous indications were re-identified; ~~19~~ 27 new relevant indications were identified in 2007 because of increased scope and improved VT resolution compared to 2004; and 18 previous indications were <u>not</u> re-identified in 2007~~, either~~ due to surface conditions~~, or because the~~ 1 and 9 previous indication~~s~~ 5 ~~was~~ were determined to be non-relevant.

Q47. What was your role in those inspections?

A47. (LDL) Having become acting Supervisor of Code Programs, my role in the Fall 2005 outage was to ensure the proper completion and evaluation of the steam dryer inspections, as well as other Code-required tests and inspections.

In 2007, I was again directly involved in the oversight of all Code Programs inspection and testing activities. As related to the steam dryer inspections, I had multiple daily contacts with NDE Level II, Level III, and supervisory personnel to monitor the progress and appropriateness of steam dryer inspections and their timely evaluation and resolution. I was directly involved in the conclusions and decisions regarding the evaluation and resolution of steam dryer indications, and participated in the telephone conversation with the NRC staff in which we reported our preliminary examination results prior to startup.

Q48. How were the steam dryer inspections and evaluations conducted?

A48. (LDL) The inspections were performed using the VT-1 visual examination technique. The examinations were performed by qualified Level II NDE personnel, using approved industry standard techniques, and the results were evaluated by qualified Level III NDE personnel. As previously discussed, as an additional quality check, 100% of the steam dryer examinations were reviewed and accepted by qualified Entergy Level III NDE personnel. The examination video, which was directly recorded in color, was transmitted to the reactor vendor structural engineers, who had access to exactly the same information that the NDE technicians used to make the initial assessment that 75 indications were recordable. These evaluations were reviewed, discussed, and accepted by Entergy Level III NDE personnel, structural engineering and site management. Both Entergy and the reactor vendor's structural engineers agreed that none of the indications required repair.

Q49. What have been the results of the steam dryer inspections conducted while the EPU was being implemented and thereafter?

A49. (LDL) As noted earlier, the Spring 2004 steam dryer baseline inspections found 20 indications, of which 2 were repaired and the remainder (18) were deemed acceptable for "use as-is." All of the indications were evaluated, and none were determined to be fatigue cracks.

The Fall 2005 steam dryer inspection found 66 indications, including the 20 identified in 2004, all of which were evaluated and dispositioned "use as-is." None of the previously identified indications showed growth, which suggests that fatigue is not occurring. Further, the fact that none of the previously identified indications showed growth in the 2005 inspection is evidence that the additional indications were in all likelihood not new, but simply became visible due to the enhanced examination capability. Again, all of the indications were carefully evaluated, and in no instance was any indication of fatigue evident.

The steam dryer inspections conducted in the Spring of 2007 followed approximately one year of full power operation at the EPU condition. The examinations were again conducted using enhanced examination resolution, which provides improved detection levels over those achievable by using the prescribed VT-1 examination process. Due to differences in surface conditions and illumination, some conditions that were identified as indications in 2005 were no longer identified as such in 2007. As a result, 47 of the 66 indications identified in 2005 were again identified in 2007.

In addition, 19 new indications were identified for a total of 66 dryer indications. Each of these 66 indications was evaluated by qualified structural engineers, experienced in evaluating indications in BWR steam dryers. Each of the indications was accepted to "use as-is." No growth was noted in the previously identified indications. None of the cracks were determined to be associated with fatigue.

IV. RESPONSE TO CLAIMS IN NEC'S TESTIMONY AND EXHIBITS ON NEC CONTENTION 3

Q50. Have you had the opportunity to review the testimony and exhibits submitted by NEC in this proceeding on April 28, 2008 relating to NEC Contention 3?

A50. (JRH. LDL) Yes, we have.

Q51. What testimony did you review?

A51. (JRH, LDL) We reviewed the direct testimony of Joram Hopenfeld, NEC Exhibit NEC-JH_01; Dr. Hopenfeld's report entitled "Assessment of Proposed Program to Manage Aging of the Vermont Yankee Steam Dryer Due to Flow-Induced Vibrations" (April 25, 2008), NEC Exhibit NEC-JH 54 ("NEC

Dryer Report"); and NEC Exhibits NEC-JH_ 55 through NEC-JH_61.

Q52. What are the main claims raised in NEC's testimony and exhibits on Contention 3?

A52. (JRH, LDL) NEC's consultant Dr. Joram Hopenfeld makes two main claims regarding the VY steam dryer management program: (1) that monitoring of plant parameters indicative of potential dryer cracks is insufficient to prevent fatigue cracks from forming and propagating in the period between dryer inspections: and (2) that a dryer management program must include estimating the stress loadings on the dryer and ensuring that they remain within the stress limits of the dryer material.

A. Alleged Limitations in Steam Dryer Monitoring Program

Q53. In the NEC Dryer Report, Dr. Hopenfeld states that "[m]oisture monitoring only indicates that a failure has occurred; it does not prevent the failure from occurring." NEC Dryer Report at 5. Is monitoring subject to the limitation described by Dr. Hopenfeld?

A53. (JRH) No. Monitoring of plant parameters will not predict the incipient formation of dryer cracks, but it will identify the existence of a crack sufficiently large to adversely affect dryer performance and flag the risk of structural failure of the dryer. Since the steam dryer has completed two years of EPU operations and will have completed eight years of operation at EPU conditions prior to entering the period of extended operation in 2012, such extended operation without the detection of large cracks provides a high degree of assurance that the steam dryer is not subject to rapid flaw growth due to high cycle fatigue. Thus, the monitoring program is sufficient to provide an "early warning" of potential dryer failure so that action can be taken prior to the occurrence of such failure.

Q54. Dr. Hopenfeld also states: "Most parameter monitoring (moisture, steam flow, water level, dome pressure) may indicate the formation of only those steam dryer cracks that increase moisture carryover; those cracks that do not lead to significant moisture carryover may continue to grow undetected." NEC Dryer Report at 4. Is this a valid concern?

A54. (JRH) No. The steam dryer is a direct part of the steam flow path in the reactor. Unexplained changes in steam flow rate, reactor vessel water level and/or steam dome pressure can each be indicative of a change in the overall steam path pressure drop, and therefore a loss in dryer efficiency that may be caused by steam dryer damage. That is why these parameters are continuously monitored. Since all the reactor steam flows through the steam dryer, it is very unlikely that any damage to the dryer would not also result in a decrease in efficiency of the steam dryer (and thus result in an increase in moisture carry-over and a change in one or more of the monitored parameters).

Q55. Dr. Hopenfeld further asserts (NEC Dryer Report at 1-2) that "the history of steam dryer cracking at the VY plant indicates that Entergy's program to date of visual inspection and moisture monitoring have been ineffective in identifying cracking at the time it occurs, when it occurs in between inspections." What is your response to this assessment?

A55. (LDL) Dr. Hopenfeld misunderstands the purpose of the current and proposed steam dryer management program at VY. Entergy's program of visual inspections and moisture carryover and other parameter monitoring uses the latest approved examination techniques and is consistent with the current industry best practice. All monitoring programs—including the inservice inspection program, which forms the basis for assuring the continued integrity of the reactor coolant system—are based on the principle that periodic monitoring and inspection, informed by the knowledge of plant materials and the physics of stress, strain, flaw initiation and crack propagation, will monitor material conditions on a frequency that is sufficient to identify and mitigate any flaws before they can grow to a size that would be detrimental to the integrity of the component under consideration.

The results of the steam dryer inspection and monitoring program have been quite effective to date and will continue to be effective after license renewal. The program has demonstrated that steam dryer integrity can be assured by periodic inspection and monitoring. The overwhelming majority of visual indications have not grown since they were first identified, and those few indications that were determined to need repair had not reached critical size (that is, they had not had a negative effect on steam dryer integrity) prior to repair. They also have not shown evidence of new growth since they were repaired.

Q56. Dr. Hopenfeld goes on to state (NEC Dryer Report at 3) that, once fatigue cracks initiate, they propagate very fast when exposed to alternating stresses of sufficient magnitude and frequency, so that even if one does not find cracks during an inspection, there is absolutely no reason why such cracks would not start propagating once the plant is restarted. Is this concern well founded?

A56. (LDL) Dr. Hopenfeld's concern is based on the assumption that there will be alternating stresses of sufficient magnitude and frequency to cause cracks to propagate rapidly. However, VY's operating experience after the EPU (exemplified by the data collected during the 2007 inspection and the subsequent year of monitoring of plant operating parameters) demonstrates that the stresses experienced by the dryer are insufficient to initiate and propagate fatigue cracks. Therefore, as the examinations in 2007 show, there is reasonable assurance that there are no stresses sufficient to initiate and propagate a fatigue crack in the Vermont Yankee steam dryer.

Q57. Dr. Hopenfeld further notes (NEC Dryer Report at 3) that, in its evaluation of the indications found during the 2007 refueling outage, General Electric determined that the indications were IGSCC cracks but "GE did not rule out the possibility of continued crack growth by fatigue." Is his comment correct?

A57. (LDL) The reference cited by Dr. Hopenfeld and included with his testimony (Exhibit NEC-JH_59) contains no such statement. What General Electric actually stated was: "It is recommended that the visual indications reported in References 1 and 2 be accepted as-is for continued operation for at least one additional operating cycle. Repair is not recommended at this refueling outage. These indications are most likely IGSCC and therefore they will propagate very slowly if at all. These indications have little or no structural impact on the steam dryer assembly and do not pose a risk of creating lost parts during the next operating cycle. These indications should be visually inspected during the next refueling outage to confirm there has been little or no growth." See Exhibit E3-16 at 4. There is no doubt, based on the history of the indications inspected during the 2007 refueling outage, that they are IGSCC cracks and not fatigue cracks.

Q58. Do the results of the most recent dryer inspections shed any light on the long term outlook for the physical integrity of the VY steam dryer?

A58. (LDL) Yes. The most recent steam dryer inspections show that the VY steam dryer has a modest number of IGSCC and stress relief indications typical of its age and service. These inspections show that none of the indications identified to date are active; that is, they exhibit no discernible growth from one inspection to the next.

B. Alleged need to estimate dryer stress loads

Q59. What are the stress loadings to which steam dryers are subjected during plant operations?

A59. (JRH) There are two types of stress loadings imposed on the steam dryer (as well as other plant components) during nuclear power plant operations. There are the normal operating loads that are experienced day-in and day-out over the life of the plant. These loads are generally lower than the design basis (accident) loads, but because of their long duration or frequency they can induce fatigue damage. The design basis loads, on the other hand, are one-time loads. It is the normal operating loads that can cause the eventual failure of a steam dryer from vibration-induced fatigue.

Q60. NEC consultant Dr. Joram Hopenfeld asserts that the aging management program for the VY steam dryer should include "some means of estimating and predicting stress loads on the dryer, establishing load fatigue margins, and establishing that stresses on the dryer will fall below ASME fatigue limits" (Pre-Filed Direct Testimony of Dr. Joram Hopenfeld Regarding NEC Contentions 2A, 2B, 3 and 4, NEC Exhibit NEC-JH_01 at A16). Do you agree with Dr. Hopenfeld's assessment of the necessity of "estimating and predicting" stress loads on the steam dryer as part of the steam dryer aging management program?

A60. (JRH) No. While it is appropriate to estimate and predict stress loads on the steam dryer during the plant design and for the design validation performed for the EPU, it is not necessary to do so as part of the steam dryer aging management program, and there is no regulatory requirement or industry guidance that calls for ongoing estimation of steam dryer stresses.

Q61. Why is it not necessary to estimate and predict dryer stresses?

A61. (JRH) Confirmation that stresses on the VY steam dryer remain within its fatigue limits is provided daily by the fact that the dryer has been able to withstand without damage the increased loads imparted on it during power ascension and for the two years of operation since the EPU was implemented. Dryer performance to date demonstrates that none of the stresses on the dryer has exceeded the endurance limit for the component. It is important to note that there will be no change in dryer loads or stresses during the license renewal period of operation; hence, there is no reason to expect that the dryer will be subjected to increased stresses in the future.

Also, as I indicated earlier, the dryer monitoring program, supplemented by the periodic dryer inspections during refueling outages, is sufficient to diagnose whether significant dryer cracking has occurred before such cracking results in dryer failure. The same approach is used in other aspects of fatigue monitoring in the reactor system components, whose fatigue monitoring program does not require the estimation or prediction of actual loads on the components.

C. Effect of Uprate on Steam Dryer Performance

Q62. In the NEC Dryer Report (at 3-4) Dr. Hopenfeld asserts that, as a result of the EPU implemented by Entergy in 2006, there has been a 20% increase in steam flow velocity, which in turn has increased the potential for fluctuating local pressure loadings on the dryer that may approach the natural frequency of the dryer. Is this a valid concern?

A62. (JRH) No. Industry experience shows that BWR steam dryers in use during uprated power operations that have inadequate fatigue resistance will most likely exhibit this inadequacy during the first fuel cycle. In other words, operation of a steam dryer for a year or two is sufficient to accumulate enough fatigue cycles to cause significant cracking in susceptible areas of the dryer. Conversely, good performance (such as exhibited by the VY steam dryer) during the first operating cycle after the uprate strongly suggests that the dryer will not experience a fatigue-induced failure.

Q63. Dr. Hopenfeld also expresses the view (NEC Dryer Report at 6) that instead of removing the instrumentation used during the power ascension phase of implementing the extended power uprate to estimate the loadings on the steam dryer. Entergy should have improved the analytical tools for predicting the loads on the dryer, perhaps by conducting additional scaling test at GE at the San Jose facility. Do you agree with this view?

A63. (JRH) No. The analytical tools that were used during the uprate proceeding to demonstrate that loads on the dryer will be below its endurance limits were performed as part of the design validation process that demonstrated the adequacy of the design and established the current licensing basis. Because the predicted loads on the dryer were shown to be below the endurance limit, the design analysis was not time limited and thus does not need to be revisited at the license renewal stage, where only time limited aging analyses need to be evaluated. Further, the loadings on the dryer derive from plant geometries (pipe lengths, diameters, flows, pipe connections, etc.). Those have not changed since the uprate was implemented, so there has been no change to the loadings on the dryer and the resulting stresses. Therefore, there is no reason to provide continued instrumentation to measure loadings or further analytical efforts.

Q64. Are the stresses on other plant components, such as piping, measured or monitored during normal plant operations?

A64. (JRH) No, they are not. Nor is there need for such measurements. For those components, as for the steam dryer, a "defense in depth" approach is implemented, involving: 1. conservative prediction of loads; 2. conservative structural analyses to ensure stress limits are satisfied; 3. confirmation of design during start-up testing; and 4. periodic inspections to confirm satisfactory performance or provide early warning of unexpected performance. The first three of these actions occur as part of the design process, or during the design validation for an uprate. Thereafter, as the facility operates, the inservice inspection program, which is conducted to the requirements of 10 C.F.R. § 50.55a and the ASME Boiler & Pressure Vessel Code, Section XI examines feedwater nozzles, core spray nozzles, reactor recirculation nozzles, main steam nozzles and other components that have been determined potentially susceptible to fatigue. All of these ISI inspections are conducted to monitor safety-related piping and components for aging effects due to fatigue and other environmental factors. Routine inservice inspections have proven effective for monitoring the condition of piping and components and detecting early indications of aging, well before those components degraded to the point that their integrity might be compromised. These methods of component integrity monitoring do not rely on stress measurements.

The ISI program performs periodic visual and surface examinations, as well as volumetric examinations using ultrasonic tests ("UT") of the thickness of a pipe wall or weld on certain safety related welds and nozzle connections. By monitoring the condition of the metal through the pipe wall from the inside diameter to the outside diameter, any change in the metal subject to this UT examination is noted and evaluated in the corrective action program. The ISI program is a monitoring and trending program that does not rely on detailed stress analysis or direct stress measurements.

V. SUMMARY AND CONCLUSIONS

Q65. Please summarize your testimony.

A65. (JRH, LDL) Our testimony can be summarized as follows:

- Entergy has instituted a program, currently in effect and to be continued after renewal of the VY license, to continuously monitor plant parameters indicative of potential cracking of the steam dryer and properly evaluate and respond to any significant departures of those parameters from their normal range. That program is in accordance with industry guidelines and has been accepted by the NRC Staff for implementation during the current period of plant operations at uprated power level.

- Entergy has instituted a program, currently in effect and to be continued after VY license renewal, to perform during each refueling outage thorough visual inspections of the areas of the steam dryer potentially susceptible to crack formation. These inspections are conducted in accordance with industry guidelines and their methodology has been accepted by the NRC Staff for implementation during the current period of plant operations at uprated power level.

- The most recent steam dryer inspections show that the VY steam dryer has a modest number of service induced stress relief indications typical of its age and service. These inspections show that none of the indications identified to date are active; that is, they exhibit no discernible growth from one inspection to the next.

- The fact that the VY steam dryer has shown no evidence of fatigue induced cracks after two years of EPU operation strongly indicates that routine inspection of the steam dryer during the period of extended operation will be sufficient to provide reasonable assurance of continued steam dryer integrity.

- The steam dryer inspection and monitoring plan that Entergy will implement during the period of extended operation after license renewal will assure that the aging effects on the steam dryer will be adequately managed.

Q66. What are your conclusions regarding the assertions in NEC Contention 3?

A66. (JRH, LDL) We conclude that there is no factual support for the claims made in NEC Contention 3.

Q67. Does that conclude your testimony?

A67. (JRH, LDL) Yes, it does.

MR. TRAVIESCO-DIAZ: Mr. Chairman, we also have marked a set of exhibits to this testimony which are numbered Exhibits A302 through A316. One of those exhibits A315 has corrections and those corrected exhibits have been handed over to the parties and to the Board. And I would move that all these exhibits be admitted into evidence at this point.

JUDGE KARLIN: Any objections from the parties?

Hearing none, they're admitted.

Thank you, Mr. Diaz.

NRC staff, Ms. Baty?

MS. BATY: Actually, Ms. Bielecki is going to --

JUDGE KARLIN: Okay, Ms. Bielecki.

MS. BIELECKI: Mr. Scarbrough, could you please state your full name for the record?

MR. SCARBROUGH: Tom G. Scarbrough.

MS. BIELECKI: Mr. Hsu, will you please state your name?

MR. HSU: Kaihwa Robert Hsu.

MS. BIELECKI: And Mr. Rowley?

MR. ROWLEY: Jonathan Gabriel Rowley.

MS. BIELECKI: Do you have before you the affidavit of Kaihwa Robert Hsu, Jonathan G. Rowley, and Thomas G. Scarbrough concerning NEC's contention 3, steam dryer?

MR. HSU: I do.

MR. ROWLEY: I do.

MR. SCARBROUGH: I do.

MS. BIELECKI: And did you prepare this testimony for this proceeding?

MR. HSU: Yes.

MR. ROWLEY: Yes.

MR. SCARBROUGH: Yes.

MS. BIELECKI: Do any of you have any corrections to this testimony?

MR. HSU: No.

MR. ROWLEY: No.

MR. SCARBROUGH: No.

MS. BIELECKI: Have you prepared a statement of professional qualifications?

MR. HSU: Yes.

MR. ROWLEY: Yes.

MR. SCARBROUGH: Yes.

MS. BIELECKI: Is it attached thereto?

MR. HSU: Yes.

MR. SCARBROUGH: Yes.

MR. ROWLEY: Yes.

MS. BIELECKI: Do you adopt this testimony as your initial testimony in this proceeding?

MR. HSU: Yes.

MR. SCARBROUGH: Yes.

MR. ROWLEY: I do.

MS. BIELECKI: I move this testimony into evidence, Your Honor.

JUDGE KARLIN: All right, any objections? Hearing none, it's admitted. Thank you.

(Whereupon, the affidavit of Kaihwa Robert Hsu, Jonathan G. Rowley, and Thomas G. Scarbrough was admitted into evidence.)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC	)	Docket No. 50-271-LR
AND ENTERGY NUCLEAR OPERATIONS, INC.	)	
	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF KAIHWA R. HSU,
JONATHAN G. ROWLEY, AND THOMAS G. SCARBROUGH
CONCERNING NEC CONTENTION 3 (STEAM DRYER)

Q1. Please state your name, occupation, and by whom you are employed.

A1(a). My name is Kaihwa R. Hsu ("Hsu").[1] I am employed by the Nuclear Regulatory Commission ("NRC") as a senior mechanical engineer in the Division of Engineering in the Office of New Reactors ("NRO"). Previously I was employed as a materials engineer in the Office of Nuclear Reactor Regulation ("NRR") Division of License Renewal ("DLR"). A statement of my professional qualifications is attached hereto.

A1(b). My name is Jonathan G. Rowley ("Rowley"). I am employed by the NRC as a project manager in NRR/DLR. A statement of my professional qualifications is attached hereto.

A1(c). My name is Thomas G. Scarbrough ("Scarbrough"). I am employed by the NRC as a senior mechanical engineer in the NRO Division of Engineering. Previously, I was assigned as a senior mechanical engineer in the NRR Division of Component Integrity. A statement of my professional qualifications is attached hereto.

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[1] In this testimony, the sponsors of each numbered response are identified by their last name; no such designation is provided for paragraphs which are sponsored by all witnesses.

Q2. Please explain your duties in connection with the staff's review of the License Renewal Application ("LRA") submitted by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. ("Entergy," "Applicant," "Vermont Yankee," or "Licensee").

A2(a). (Hsu) In connection with the staff's review of the LRA, I was an Audit Team Member for the license renewal safety audit at Vermont Yankee. I served as technical lead for activities related to the Vermont Yankee LRA. I also reviewed the Vermont Yankee LRA including the following aging management programs: B.1.4, "BWR Penetrations;" B.1.5, "BWR Stress Corrosion Cracking;" B.1.6, "BWR Vessel ID Attachment Welds;" B.1.7, "BWR Vessel Internals;" and B.1.29, "Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel," including preparation of Section 3.0.3.1.2 of the Safety Evaluation Report. I also reviewed the Time-Limited Aging Analysis and prepared Sections 4.1, 4.3 and 4.7 of the Safety Evaluation Report.

A2(b). (Rowley) I am the lead project manager for the staff's safety review of the Vermont Yankee license renewal application. I serve as the principal point of contact in NRR for activities related to the Vermont Yankee LRA. I coordinated the staff's evaluation of Vermont Yankee LRA and preparation of the staff's Safety Evaluation Report with Confirmatory Items, which was issued to the public in March 2007. In addition, I coordinated the staff's final Safety Evaluation Report, which was issued to the public in February 2008.

A2(c). (Scarbrough) I have not participated in the staff's review of Vermont Yankee's LRA. However, as part of my official responsibilities, I participated in the review of potential adverse flow effects on nuclear power plant components (including the steam dryer) from the proposed operating conditions for the Vermont Yankee Extended Power Uprate ("EPU") license amendment request, including assisting in the preparation of the Section 2.2.6, "Additional Review Area - Potential Adverse Flow Effects," of the staff's Safety Evaluation ("SE") issued on March 2, 2006 (Staff Exh. 14).

Q3. What is the purpose of your testimony?

A3. The purpose of this testimony is to present the staff's position regarding NEC Contention 3 (Steam Dryer). As admitted by the Board, LBP-06-20, 64 NRC 131, 187-191 (2006), NEC's contention alleges that "Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation." We have read relevant portions of the SER; LPB-06-20, 64 NRC 131 (2006); NEC's "Petition for Leave to Intervene, Request for Hearing and Contentions" (May 26, 2006); "Entergy's Motion for Summary Disposition of New England Coalition's Contention 3 (Steam Dryer)" (Apr, 19, 2007); NEC's "Opposition to Entergy's Motion for Summary Disposition of NEC's Contention 3 (Steam Dryer)" (May 9, 2007); NEC's "Supplement to Opposition to Entergy's Motion for Summary Disposition of New England Coalition Contention 3 (Steam Dryer)" (July 19, 2007); and "Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 3)" (Sept. 11, 2007) (unpublished).

Q4. Describe Entergy's program to monitor and manage the effects of aging on Vermont Yankee's steam dryer during the period of extended operations.

A4(a). (Rowley) Entergy has committed (SER Commitment No. 37) (Staff Exh. 1) to continue inspections in accordance with its Steam Dryer Monitoring Plan ("SDMP"), Revision 3, in the event that the Boiling Water Reactor and Vessel Internals Project ("BWRVIP")-139 "Steam Dryer Inspection and Flaw Evaluation Guidelines," is not approved prior to the period of extended operation. The BWRVIP is the BWR Vessels and Internals Project of the nuclear industry with participation by the Electric Power Research Institute ("EPRI"). The BWRVIP Steam Dryer Focus Group developed guidelines for steam dryer inspections and flaw evaluation in BWRVIP-139.

A4(b). (Scarbrough) Entergy described its SDMP for monitoring and evaluating the performance of the Vermont Yankee steam dryer during power ascension testing and operation above then-Current Licensed Thermal Power ("CLTP") to full EPU conditions in Attachment 6 to Supplement 33 (dated September 14, 2005) of its EPU license amendment request. Entergy defined unacceptable steam dryer performance as a condition that could challenge steam dryer structural integrity and result in the generation of loose parts, cracks or tears in the dryer that result in excessive moisture carryover.

As planned in the SDMP, Entergy monitored plant parameters during the EPU power ascension following issuance of the EPU license amendment on March 2, 2006, to confirm that pressure loads on the steam dryer resulted in stresses that remained below the fatigue stress limits in the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code. In its SDMP, Entergy stated that the Vermont Yankee steam dryer would be inspected during refueling outages scheduled for fall 2005, spring 2007, fall 2008, and spring 2010, according to recommendations in GE Services Information Letter (SIL) No. 644, Revision 1 (November 9, 2004). The SDMP indicates that moisture carryover measurements will continue to be made periodically, and other plant operational parameters that may be affected by steam dryer structural integrity will continue to be monitored, in accordance with GE SIL 644 and plant procedures. In the EPU License Amendment dated March 2, 2006 (ML060390107) (Staff Exh. 14), the

NRC established license conditions related to the EPU power ascension and long-term steam dryer monitoring. For example, License Condition 5 specifies that during each of three scheduled refueling outages (beginning with the spring 2007 refueling outage), a visual inspection shall be conducted of all accessible, susceptible locations of the steam dryer, including flaws left "as is" and modifications. License Condition 6 specifies that the results of the visual inspections of the steam dryer conducted during three scheduled refueling outages (beginning with the spring 2007 refueling outage) shall be reported to the NRC staff within 60 days following startup from the respective refueling outage. The license condition also states that the results of the SDMP shall be submitted to the NRC staff in a report within 60 days following the completion of all EPU power ascension testing. License Condition 7 specifies that the requirements for meeting the SDMP shall be implemented upon issuance of the EPU license amendment and shall continue until the completion of one full operating cycle at EPU conditions. If an unacceptable structural flaw (due to fatigue) is detected during the subsequent visual inspection of the steam dryer, the license condition states that the requirements for meeting the SDMP shall extend another full operating cycle until the visual inspection standard of no new flaws/flaw growth based on visual inspection is satisfied. License Condition 8 states that the license condition shall expire upon satisfaction of the requirements in License Conditions 5, 6, and 7 provided that a visual inspection of the steam dryer does not reveal any new unacceptable flaw or unacceptable flaw growth that is due to fatigue.

If BWRVIP-139 is approved prior to the period of extended operations, Entergy would convert to BWRVIP-139 guidelines from GE SIL 644. BWRVIP-139 provides detailed steam dryer information, including (1) discussion of steam dryer configurations for different plants, (2) summary of steam dryer operating experience, (3) discussion of susceptibility for fatigue cracking and intergranular stress corrosion cracking, (4) discussion of failure modes and effects of cracking in steam dryer components, (5) discussion of relative stresses in different steam dryer components, (6) inspection recommendations for different steam dryer designs, (7) examples of evaluation approaches for steam dryer cracking, and (8) operational guidance for monitoring moisture carryover. If the NRC staff accepts BWRVIP-139, Entergy will be able to use the updated inspection guidelines in the BWRVIP document at Vermont Yankee.

4(c). (Hsu, Rowley) The staff finds the implementation of BWRVIP-139 acceptable because BWRVIP-139 will provide guidance for use of the latest methods and technology to manage steam dryer degradation during the period of extended operation. BWRVIP-139 will be continuously updated to incorporate newly acquired industry operating experience information and improved technology. In the case that BWRVIP-139 is not approved, the staff finds continued use of the SDMP acceptable. The SDMP incorporates the GE-SIL-644 which will include updated industry operating experience and technology. Either procedure will assure that Entergy will continue to inspect and monitor the steam dryer using the latest information and techniques available during the extended period of operation.

Q5. Describe the staff's review of Entergy's program for managing the effects of aging on the steam dryer.

A5(a). (Scarbrough) The NRC staff reviewed Entergy's SDMP as part of the evaluation of the EPU license amendment request for Vermont Yankee. The NRC obtained technical assistance from Argonne National Laboratory and its subcontractors in reviewing the structural improvements to the Vermont Yankee steam dryer, Entergy's analysis of the capability of the modified steam dryer to maintain its structural integrity under EPU conditions, and the EPU power ascension testing program and long-term inspection and monitoring plan. The staff determined that Entergy had demonstrated that the stress on the modified steam dryer resulting from EPU operation at Vermont Yankee would remain below the fatigue stress limits specified in the ASME Code such that significant fatigue cracks are not expected to occur in the steam dryer during long-term EPU operation. The NRC staff documented the results of its review in the SE on the EPU license amendment request for Vermont Yankee attached to the license amendment dated March 2, 2006 (ML060050028) (Staff Exh. 14). The NRC staff monitored the EPU power ascension process at Vermont Yankee based on plant data provided by Entergy and through numerous interactions with Entergy personnel to confirm that plant performance was consistent with the steam dryer analysis presented by Entergy. The staff also reviewed the information obtained during the steam dryer inspection in spring 2007 to confirm that no significant fatigue cracking had occurred in the steam dryer during EPU operation.

A5(b). (Rowley, Hsu) As it relates to license renewal, the applicant stated that cracking due to flow-induced vibration in the stainless steel steam dryers is managed by the BWR Vessel Internals Program. The BWR Vessel Internals Program currently incorporates the guidance of GE-SIL-644, Revision 1. VYNPS will evaluate BWRVIP-139 once it is approved by the staff and either include its recommendations in the VYNPS BWR Vessel Internals Program or inform the staff of Entergy's exceptions to that document.

The staff finds the applicant's approach for managing cracking of steam dryers due to flow-induced vibration to be acceptable because the approach will be based on the guidelines developed by the ongoing activity of the BWRVIP. In addition, Entergy has committed (SER Commitment No. 37) to continue inspections in accordance with the SDMP, Revision 3, in the event that BWRVIP-139 is not approved prior to the period of extended operation.

Q6. What did the staff conclude about Entergy's steam dryer aging management program?

A6a. (Scarbrough) As indicated in the SE on the Vermont Yankee EPU license amendment request, the NRC staff concluded that Entergy's program provided reasonable assurance that the flow-induced effects on the steam dryer were within the structural limits at then-CLTP conditions. The staff further concluded that Entergy had demonstrated that the steam dryer would continue to meet the requirements of the NRC regulations following implementation of the EPU at Vermont Yankee, subject to the license conditions specified in the EPU license amendment. The staff determined that the results of the EPU power ascension and the spring 2007 steam dryer inspection had confirmed the structural capability of the steam dryer for EPU operation.

A6(b). (Rowley, Hsu) To reach its conclusion in the SER for license renewal, the staff reviewed plant experience at numerous plants related to plant transients after extended power uprates and did not observe any abnormal behavior in the steam dryers.

On the basis of the operating experience and the EPU license conditions, the staff concluded that there is reasonable assurance that the VYNPS steam dryers will perform satisfactorily under EPU conditions during the proposed renewal period provided an adequate aging management program is used. The staff found the BWR Vessel Internals Program and the SDMP to be adequate methods to manage aging of the steam dryer. Also, if approved, BWRVIP-139 will be an adequate method to manage aging of the steam dryer.

In addition, Vermont Yankee SER Commitment No. 51 (Staff Exh. 1) states that "Entergy will perform an evaluation of operating experience at EPU levels prior to the period of extended operation to ensure that operating experience at EPU levels is properly addressed by the aging management programs. The evaluation will include Vermont Yankee and other BWR plants operating at EPU level." This Commitment addresses the recommendation in Section 3.0.2 of the NUREG-1800 "Standard Review Plan for Review of License Renewal Application of Nuclear Power Plant" Rev. 1 (September 2005) (Staff Exh. 19) that license renewal applicants with approved EPUs commit to performing an operating experience review assessing the impact of the EPU on aging management programs for structures, systems, and components prior to the period of extended operation. Commitment No. 51 is therefore acceptable to the staff.

Q7. Does Entergy's steam dryer aging management program include continuous monitoring of plant parameters indicative of potential cracking by competent engineers?

A7. (Scarbrough, Hsu) Entergy's SDMP includes periodic monitoring of moisture carryover to identify degraded performance of the Vermont Yankee steam dryer in removing moisture from the steam exiting the reactor core. The SDMP also states that other reactor operational parameters that may be influenced by steam dryer integrity will be monitored with the intent of detecting structural degradation of the steam dryer during plant operation. For example, changes in the distribution of steam flow between individual steam lines can indicate degradation of the steam dryer. Entergy personnel will monitor plant data as part of their operational responsibilities. Based on interaction with Entergy personnel during the review of the EPU license amendment request and monitoring of the EPU power ascension, the NRC staff considers Entergy personnel to be competent to obtain and evaluate plant data to identify potential steam dryer structural degradation.

Q8. How long does it take for crack to grow to a size such that it could result in the generation of loose parts?

A8. (Scarbrough) Operating experience at the Quad Cities nuclear power plant revealed that significant cracking of a steam dryer can occur within a few months if the fatigue stress limit for the material is exceeded by acoustic or hydraulic loading.

Q9. NEC asserts that cracks in the steam dryer grow quickly and thus a crack could develop between inspection and lead to the generation of loose parts. Do you agree? If not, do the initial indications of a crack take a number of cycles to even become an issue?

A9. (Scarbrough) It is agreed that cracks can grow quickly within a steam dryer if the fatigue stress limit for the material is exceeded. However, the strain gage data obtained during the EPU power ascension at Vermont Yankee indicated that the steam dryer loading did not result in stress in the steam dryer that exceeded the fatigue stress limit. Minor indications and cracking are typically identified during steam dryer inspections. These minor indications and cracking do not cause concerns for the generation of loose parts over the interval between steam dryer inspections.

Q10. Is Entergy's steam dryer aging management program sufficient to detect potential degradation of the steam dryer during operations?

A10. (Scarbrough) Yes. Moisture carryover and the monitoring of other plant parameters would reveal a significant degradation of the steam dryer if it occurred.

Q11. Are analytical tools required to interpret plant parameter data? If so, does

Entergy's program include such tools?

A11. (Scarbrough) Entergy used detailed analytical tools as part of the structural analysis to support the Vermont Yankee steam dryer capability for the EPU license amendment request and during the EPU power ascension. The monitoring of plant data, such as moisture carryover and steam flow mismatch, is part of the normal duties of plant personnel and does not require analytical tools of the complexity used as part of the steam dryer stress analysis to support the EPU license amendment. The steam dryer inspections during refueling outages are performed by experienced personnel using industry-accepted visual inspection techniques following GE-SIL-644 and BWRVIP-139 guidance documents.

Q12. What are the qualifications of the individuals who will analyze plant parameter data? Explain why those persons are competent?

A12. (Scarbrough) Vermont Yankee plant personnel are trained to monitor plant data for abnormalities through the reactor operator licensing process. If abnormalities are identified, detailed evaluations are performed by Entergy engineering staff. Based on its review of the EPU license amendment request and the EPU power ascension, the NRC staff considers Entergy to be capable of analyzing plant data related to steam dryer performance in an adequate manner.

Q13. Does Entergy's aging management program for the Vermont Yankee steam dryer include a method for estimating and predicting dryer stress loads? If yes, describe the method and opine on the reliability of the method. If not, explain why a method for estimating and predicting stress loads is not a necessary component of a steam dryer aging management program.

A13. (Scarbrough) Entergy's aging management program for the Vermont

Yankee steam dryer does not include a method for estimating and predicting dryer stress loads. Entergy performed detailed stress analyses of the Vermont Yankee steam dryer in support of the EPU license amendment request. During EPU power ascension, Entergy analyzed plant data to confirm that the pressure loads on the steam dryer during EPU operation do not result in stress that exceeds the fatigue limits in the ASME Code. With the determination that the pressure loads on the steam dryer during EPU operation are acceptable with the resulting stress below the fatigue limit, further stress analyses are not necessary for the Vermont Yankee steam dryer unless plant data or inspections indicate the need for additional detailed evaluations. Therefore, monitoring of plant data and periodic inspection of the steam dryer during refueling outages constitutes a reasonable approach for evaluating the aging of the steam dryer over the long term and determining whether more detailed analyses are necessary.

Q14. Has the staff reviewed and found adequate a stress load analysis for the steam dryer during the period of license renewal? If so, describe the analysis and explain why the staff found it adequate. If not, explain why a stress load analysis for the steam dryer during the license renewal period is unnecessary (in other words, why is a stress load analysis not a necessary component of a steam dryer aging management plan).

A14. (Scarbrough) Based on the EPU license amendment review and the EPU power ascension results, the NRC staff determined that the pressure loads during EPU operation will not result in stress on the Vermont Yankee steam dryer that exceeds the fatigue stress limit in the ASME Code. See Vermont Yankee Nuclear Power Station Report on the Results of Steam Dryer Monitoring, dated June 30, 2006, BVY 06-0560 (cover letter accession number ML061870276) (Staff Exh. 15). In that the pressure loads are not expected to increase during long-term EPU operation, additional steam dryer stress analysis is not considered to be necessary unless plant data or steam dryer inspections indicate the need for more detailed evaluations.

Q15. Should Entergy's aging management program include some means for establishing dryer flow induced vibration load fatigue margins and demonstrating that the stresses on the dryer at selected locations will not exceed ASME fatigue limits? Explain why or why not.

A15. (Hsu) Entergy's aging management program does not need to include flow-induced vibration load fatigue margins because the Vermont Yankee steam dryer analysis performed in support of the EPU license amendment request and confirmed during the EPU power ascension demonstrated that the pressure loads during EPU operation do not result in stress on the steam dryer exceeding the fatigue stress limits in the ASME Code. As a result, the staff considers plant monitoring and periodic inspections of the steam dryer to be sufficient to indicate the need for any additional detailed steam dryer evaluations.

Q16. Does Entergy's aging management program rely solely on inspections and plant parameter monitoring *without* reliance on stress load analysis? If yes, explain why this is acceptable.

A16. (Scarbrough) Entergy's aging management program relies on steam dryer inspections and monitoring of plant parameters to determine whether more detailed evaluations (such as stress analysis) are necessary to provide continued confidence in the structural capability of the steam dryer for long-term EPU operation. Continuous stress analysis of the Vermont Yankee steam dryer is not necessary based on the results of the EPU power ascension program, which demonstrated that the pressure loads during EPU operation do not result in stress on the steam dryer that exceeds the ASME fatigue stress limits.

Q17. Why did the staff conclude that Entergy's program to monitor and manage the effects of aging on Vermont Yankee's steam dryer is adequate to assure that the structural integrity of the steam dyer will be maintained during the period of extended operation?

A17. The NRC staff reviewed the steam dryer analyses performed by Entergy as part of the evaluation of the EPU license amendment request for Vermont Yankee. Based on its review, the staff concluded that Entergy had demonstrated that the Vermont Yankee steam dryer will maintain its structural capability during EPU operation. During the EPU power ascension at Vermont Yankee, the staff reviewed the plant data and analyses to confirm that the pressure loads during EPU operation did not result in stress on the steam dryer that exceeded the ASME fatigue stress limits. Further, the staff reviewed the results of the Vermont Yankee steam dryer inspection in spring 2007 to verify that no significant fatigue cracking occurred during EPU operation. With the recent EPU power ascension data and the steam dryer inspection confirming the structural capability of the Vermont Yankee steam dryer during EPU operation, the staff considers that monitoring of plant parameters and periodic steam dryer inspections are sufficient to provide reasonable assurance in the structural capability of the Vermont Yankee steam dryer over the long term. More detailed evaluations of the Vermont Yankee steam dryer, including stress analysis, can be performed if determined to be appropriate based on plant data and steam dryer inspection results.

Kaihwa R. Hsu
Statement of Professional Qualifications

CURRENT POSITION:

Senior Mechanical Engineer	Division of Engineering, Office of New Reactors, U.S. Nuclear Regulatory Commission, Rockville, MD

EDUCATION:

B.S., Chung Yuan Christian College, 1975, Civil Engineering
M.S., University of South Carolina, 1981, Civil Engineering in Structural Mechanics

SUMMARY:

Over 26 years of experience in the nuclear power industry, including 22 years as a principal engineer for Westinghouse Electrical Company. Significant experience in the following areas:

- Reactor Vessel, Steam generator, Pressurizer design & analyses
- Reactor Coolant Pump, Heat exchanger design & analyses
- Stress corrosion cracking, corrosion erosion
- Fracture mechanics evaluation
- Fatigue crack growth prediction and Flaw assessment
- Fatigue evaluation and leak before break demonstration
- ASME Code Section III and XI design analyses
- License Renewal aging management

EXPERIENCE:

U.S. Nuclear Regulatory Commission, 10/2003 - Present

6/2007 to Present – Senior Mechanical Engineer, Division of Engineering, Office of New Reactor

- Technical Reviewer for new reactor licenses in the area of engineering mechanics

10/2003 to 6/2007 - Materials Engineer, Division of License Renewal, Office of Nuclear Reactor Regulation

- Audit Team Leader for the license renewal safety audit at the Palisades, Harris, and Vermont Yankee Plants

- Backup Audit Team Leader for the license renewal safety audit at the Milestone Units 2 and 3, and Nine Mile Point Units 1 and 2

- Audit Team Member for the license renewal safety audit at the Oyster Creek, Wolf Creek, D.C. Cook, Arkansas Nuclear One - Unit 2 Plants

Westinghouse Electrical Co. 1981 – 2003

Principal Engineer the following divisions of Westinghouse

- **1998-2003, Structural Material Technology**
  - o Primary water stress corrosion cracking (PWSCC) issue in reactor vessel (RV)
    - Performed all the analytical work which generated the proposed Westinghouse resolutions to plant specific problems in this area. The activities included:
      - RV CRDM/CEDM Penetration Alloy 600 Cracking & Penetration Weld Cracking
      - RV Nozzle Safe End Alloy 82/182 Butt Weld Cracking.
      - Structural Integrity Evaluation
      - Embedded Flaw Repair Technique and Procedure
      - Technical Justification for Continued Operation (JCO).
      - Alloy 82/182 Butt Weld Safety Assessment Report (EPRI MRP-44)
      - Participation in ASME Section XI Activities

- **February 1997- March 1998, Millstone Unit 3**: areas of work included
  - o 10 CFR 50.54(f) program – Specific System Review
  - o Resolution of Unresolved/Open Item
  - o FSAR Review and Preparation of FSARCR
  - o 10 CFR 50.59 Safety Evaluation for FSARCR

- **1993 – January 1997, Structural Material Technology**: areas of work included:
  - o ASME Section XI Class 1 Component Finite Element Analysis.
  - o Flaw Assessment per ASME Section XI
  - o Inspection Procedure, Material Purchasing, and Scheduling of the steam generator replacement program
  - o Pre-Operational Walk-down and Testing
  - o Inspections during Refueling Outage
  - o Fracture Mechanics and Structure Integrity
  - o Piping Stress Qualification
  - o Leak-Before-Break Demonstration
  - o Fatigue Crack Growth Prediction
  - o Time History Dynamic Analysis for AP600 Reactor Coolant Loop Piping
  - o Steam Generator Tube Plugging
  - o Transient Monitoring for Tech Specification Compliance

- **1990 – 1992, Piping Design and Qualification**: areas of work included:
  - o Piping Stress Analysis
  - o Equipment Qualification.
  - o Thermal Stratification Analysis (IEB 88-08 and 88-11)
  - o Fatigue Crack Growth Prediction
  - o Computer Codes Development for the fatigue cycle monitoring system by using the Green function to perform stress and fatigue analysis
  - o Nuclear Plant Records and Data Review to define operating transients

- **1988-1989, Structural Material Engineering**: areas of work included
  - o Finite Element Analysis of PWR Component

- Piping Stress Analysis
  - Fatigue Crack Growth Prediction
  - Thermal Stratification Analysis (IEB 88-08 and 88-11)
  - Computer Code Development for the Corrosion and Erosion Monitoring System to manage Flow Accelerated Corrosion issue
- **1983-1988, Piping Analysis and Design at Vogtle Plant Site**: areas of work included:
  - ASME Section III Piping Stress Analysis and Design
  - ANSI B31.1 Piping Stress Analysis and Design
  - Equipment Qualification
  - Instrument Tubing Design
  - Pre-Operational Walkdown and Testing

- **1981-1982, Stress Analysis at Westinghouse Tampa Division**: areas of work included:
  Equipment Qualification, Stress Analysis and Stress Report for Model F Steam

  Generator

Jonathan G. Rowley
Statement of Professional Qualifications

CURRENT POSITION:

Project Manager	Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Rockville, MD

EDUCATION:

B.S., Virginia Polytechnic Institute and State University, 1993, Materials Science and Engineering

M.S., University of Texas at Arlington, 2003, Materials Science and Engineering

SUMMARY:

Over 14 years of experience in materials science and engineering and over 3 years of experience in the nuclear reactor regulation. Significant experience in the following areas:

- Materials Engineering
- License Renewal

EXPERIENCE:

U.S. Nuclear Regulatory Commission, 08/03/2003 - Present

10/01/2006 to present – Project Manager, Division of License Renewal, Office of Nuclear Regulatory Research

- Lead Project Manager for the safety review of the Vermont Yankee Nuclear Power Station license renewal application

08/03/2003 to 10/01/2006 - General Engineer, Division of License Renewal, Office of Nuclear Regulatory Research

- Lead Project Manager for the safety review of the Donald C. Cook Nuclear Plant license renewal application

- Back-up Project Manager for the safety review of the R.E. Ginna license renewal application

Iowa Beef Processors, Assistant Laboratory Manager, 1993 – 2000:

Responsible for oversight of nine junior laboratory employees and day-to-day operations of the laboratory

Thomas G. Scarbrough
Statement of Professional Qualifications

CURRENT POSITION:

Senior Mechanical Engineer
Component Integrity, Performance, and Testing Branch II (CIB2)
Division of Engineering (DE)
Office of New Reactors (NRO)
U.S. Nuclear Regulatory Commission (NRC)
Rockville, MD

EDUCATION:

Bachelor of Arts in Physics, Rollins College, 1976

Bachelor of Nuclear Engineering, Georgia Institute of Technology, 1977

Master of Science in Mechanical Engineering, University of Maryland, 1988

PROFESSIONAL:

Registered Professional Engineer (Maryland #14453))

Member of American Nuclear Society

Member of American Society of Mechanical Engineers (ASME) Subcommittee on Qualification of Valve Subassemblies for the ASME QME-1 Standard, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants"

Previous member of ASME Subgroup on Motor-Operated Valves for the ASME *Code for Operation and Maintenance of Nuclear Power Plants*

SUMMARY:

I have over 30 years of technical experience in the field of nuclear engineering. In 1977, I began my career as an associate engineer at the Naval Reactor Facility in Idaho Falls, ID. In 1978, I joined the NRC and served in the Office of Standards Development and subsequently the Office of Nuclear Regulatory Research. In 1981, I was appointed as Special Technical Advisor to the Atomic Safety and Licensing Appeal Panel (ASLAP) for the restart of the Three Mile Island (TMI) Unit 1 nuclear power plant and, later, was appointed as Technical Advisor to the ASLAP. In 1989, I transferred to the Mechanical Engineering Branch in the NRC Office of Nuclear Reactor Regulation (NRR), and was assigned as principal engineer for the NRC staff review of the implementation of Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." In that assignment, I participated in numerous reviews and inspections of motor-operated valve (MOV) programs at operating nuclear power plants. Following the failure of the steam dryer at Quad Cities Unit 2 in 2002, I was assigned to participate in the review of potential adverse flow effects on plant components during power uprate operation. Since then, I have participated in the review of the power uprate requests for the Vermont Yankee, Browns Ferry, Hope Creek, Susquehanna, and other nuclear power plants with regard to potential adverse flow effects. In February 2007, I was assigned to the Component Integrity, Performance, and Testing Branch II in the NRC Office of New Reactors where I review component issues for proposed new reactors, and provide assistance to NRR on potential adverse flow effects for power uprates at operating nuclear power plants.

EXPERIENCE:

Senior Mechanical Engineer, NRC/NRO/DE/CIB2, February 2007 to Present

In February 2007, I was assigned to the Component Integrity, Performance, and Testing Branch II in the Division of Engineering of the NRC Office of New Reactors. In this position, I am responsible for the review of the functional design, qualification, and inservice testing (IST) programs for pumps and valves that will perform safety functions in new reactor designs to be certified and new reactors to be licensed under the NRC regulations. In addition, I review potential adverse flow effects for new reactor designs and proposed reactors that might affect pumps, valves, and other plant equipment (including steam dryers in boiling water reactors). I have assisted in the revision of the NRC Standard Review Plan and Regulatory Guide 1.20 to incorporate lessons learned from adverse flow effects on plant equipment for the review of new reactor design certifications, operating licenses, and power uprates. In providing assistance to the NRC Office of Nuclear Reactor Regulation, I participated in the review of potential adverse flow effects for the recent power uprates at the Hope Creek and Susquehanna nuclear power plants.

Senior Mechanical Engineer, NRC/NRR/Division of Engineering and Division of Component Integrity, June 1989 to February 2007

In June 1989, I joined the Mechanical Engineering Branch in NRR/DE and was assigned as principal engineer for the review of MOV performance issues at nuclear power plants. In this assignment, I coordinated the NRC staff review of the implementation of GL 89-10 at operating nuclear power plants. In addition to several supplements to GL 89-10, I was the principal contributor for GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves." I reviewed submittals from nuclear power plant licensees in response to these generic letters and participated in NRC inspections of MOV programs at nuclear power plants. I have represented the NRC staff at numerous public meetings and conferences to discuss MOV performance issues. Following the failure of the steam dryer at Quad Cities Unit 2 in 2002, I was assigned to participate in the NRC staff review of potential adverse flow effects at nuclear power plants operating at extended power uprate (EPU) conditions or requesting power uprate operation. In that assignment, I was a principal technical reviewer for the NRC staff's evaluation of the acoustic resonance issue at Quad Cities with participation at technical meetings at the NRC offices, licensee's offices, steam dryer manufacturing facility, steam dryer assembly facility, and licensee contractor's small scale test facility. I have worked closely with the NRC contractors from Argonne National Laboratory and its subcontractors from Pennsylvania State University and McMaster University in evaluating potential adverse flow effects at nuclear power plants. In response to the EPU license amendment request by the licensee of the Vermont Yankee nuclear power plant, I served as a principal technical reviewer of potential adverse flow effects on plant equipment, including the steam dryer. In this assignment, I participated in the review of information provided by the Vermont Yankee licensee in support of the EPU request as well as the results of technical evaluations performed by NRC contractors. In addition, I led an NRC staff audit of the initial steam dryer analysis for Vermont Yankee in 2004 at the General Electric (GE) offices and the GE small scale test facility in Palo Alto, CA. I also participated in meetings with the Vermont Yankee licensee and assisted in

NRC staff audits of technical documentation of the Vermont Yankee steam dryer analysis. I was a principal contributor for the documentation of the NRC staff review of potential adverse flow effects, and pumps and valves, in the NRC safety evaluation on the EPU license amendment for Vermont Yankee. Before the Advisory Committee on Reactor Safeguards, I coordinated the discussion by the NRC staff and its contractors of the results of the NRC staff review of potential adverse flow effects for the Vermont Yankee EPU license amendment. Following issuance of the Vermont Yankee EPU license amendment on March 2, 2006, I participated in the NRC staff review of plant data from Vermont Yankee during power ascension up to EPU conditions. With the reorganization of NRR in 2005, I was transferred into the Component Performance and Testing Branch in the new Division of Component Integrity with the same technical assignments.

Technical Advisor, Atomic Safety and Licensing Appeal Panel, 1981 to 1989

In 1981, I was appointed as Special Technical Advisor for the restart of the TMI Unit 1 nuclear power plant for the Atomic Safety and Licensing Appeal Panel. In this position, I reviewed technical information provided by the TMI licensee and NRC staff to assist the administrative judges of the ASLAP in the review of the Atomic Safety and Licensing Board decision on the restart of TMI Unit 1. Subsequently, I was appointed as Technical Advisor to the ASLAP. In that assignment, I provided assistance to the ASLAP administrative judges on a wide variety of nuclear engineering issues.

Mechanical Engineer, NRC Offices of Standards Development and Nuclear Regulatory Research, 1978 to 1981

In 1978, I joined the NRC in the Office of Standards Development where I participated in the development and revision of NRC regulatory guides related to mechanical engineering activities at nuclear power plants. The Office of Standards Development was subsequently incorporated into the NRC Office of Nuclear Regulatory Research.

Associate Engineer, Naval Reactor Facility, Idaho Falls, ID, 1977 to 1978

At the Naval Reactor Facility, I participated in a program to develop nuclear power engineers to assist in the training of Navy personnel in the design, operation, and maintenance of nuclear reactors.

ROTATIONAL ASSIGNMENTS AND TRAINING:

I have performed rotational assignments in the NRC Region I office in King of Prussia, PA (on two occasions) and NRC Region II office in Atlanta, GA, in section chief management positions in the reactor safety division. In addition, I assisted the NRC resident inspectors during preparation for the startup of the Comanche Peak Unit 2 nuclear power plant. I have completed numerous training opportunities at the NRC including MOV design and operation, pump design, pressurized and boiling water reactor systems, safety relief valve operation, NRC inspector performance, and radiation protection.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC	)	Docket No. 50-271-LR
AND ENTERGY NUCLEAR OPERATIONS, INC.	)	
	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF KAIHWA R. HSU

I, Kaihwa R. Hsu, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Kaihwa R. Hsu

KAIHWA R. HSU

Executed at Rockville, MD
this 13th day of May, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket No. 50-271-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF JONATHAN G. ROWLEY

I, Jonathan G. Rowley, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Jonathan Rowley
JONATHAN G. ROWLEY

Executed at Rockville, MD
this 13th day of May, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
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	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF THOMAS G. SCARBROUGH

I, THOMAS G. SCARBROUGH, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Thomas G. Scarbrough
THOMAS G. SCARBROUGH

Executed at Rockville, MD
this 13th day of May, 2008

MS. BIELECKI: We also have Staff Exhibits 14, 15, and 19. I would like to move these into evidence as well. There are no corrections.

JUDGE KARLIN: Any objections? No objections, admitted. Thank you, Ms. Bielecki.

NEC, please.

MS. TYLER: Dr. Hopenfeld's testimony regarding contention 3 has already been admitted. I now move to admit NEC's pre-filed exhibits, NEC JH-54 through NEC JH-61 and NEC JH-68 through JH-69.

JUDGE KARLIN: There are no changes on any of those?

MS. TYLER: No.

JUDGE KARLIN: Any objections to that? No. Hearing none, they're admitted as well.

With that, I think we have the preliminaries undertaken and we can turn to the contention.

I thought -- I had a couple of questions that maybe we can start with because I'm a little confused about what the aging management plan that Entergy has proposed and the staff has evaluated, what it is, what we're talking about.

If I could ask the staff to turn to -- well, it's prefiled written testimony that was formerly Exhibit 4 by the staff, question 4. Could you refer to that, please?

MS. TYLER: Judge Karlin, may I provide Dr. Hopenfeld the materials? He just indicated that he doesn't have a copy.

JUDGE KARLIN: Yes, sure. I mean we've been doing this every day. So he should have that material.

MS. TYLER: I agree.

JUDGE KARLIN: We shouldn't have to do this every time I ask a question.

I guess question is for Mr. Rowley, is that the correct way to pronounce it?

MR. ROWLEY: Rowley.

JUDGE KARLIN: Rowley, Mr. Rowley, because in question 4 on page 3 of your pre-filed testimony the question is asked: describe Entergy's program to monitor and manage the effects of aging on Vermont Yankee steam dryer during the period of extended operations.

And you refer -- and what's the answer to that? What is the plan that the steam dryer aging management plan that you currently have approved that will apply for the period of extended operation?

MR. ROWLEY: What is it?

JUDGE KARLIN: Yes. There is one entity called a steam dryer monitoring plan that was used under the uprate and there's another entity that's referred to as the BWR VIP-139 program. Which one is it?

MR. ROWLEY: Well, there's a commitment, 37 to once the staff approves the VIP-139 that the Applicant will then use that program and if it's not approved, they will continue to use their steam dryer monitor plan. It incorporates the GE SIL 644.

JUDGE KARLIN: Okay, so commitment 37. It says if BWR VIP-139 -- well, it doesn't really say that. Let's go to commitment 37. Pull that out, FSER, appendix A. Let's see what it says.

(Pause.)

Are you able to see? Let me ask a quick question Dr Wardwell has raised. The lights are dimmed to try to keep it cooler in the room. Can you all read the materials all right?

MR. ROWLEY: I can.

JUDGE KARLIN: So page A-13 of the FSER which is Staff Exhibit 1. Continuing inspections in accordance with the steam dryer monitoring plan, revision 3 in the event that BWR-139 is not approved prior to the period of extended operation.

So is the steam dryer monitoring plan revision 3 the aging management plan upon which the staff has approved or recommends approving this application?

MR. ROWLEY: It is contingent upon staff's approval of VIP-139.

JUDGE KARLIN: What if the staff doesn't approve it?

MR. ROWLEY: We do think that the steam dryer monitoring plan --

JUDGE KARLIN: Could you speak up? I didn't hear you.

MR. ROWLEY: We do think the steam dryer monitoring plan will adequately manage the aging of the steam dryer.

JUDGE KARLIN: Okay, so there's sort of a fork in the road coming about whether or not the staff approves the BWR VIP-139.

MR. ROWLEY: Correct.

JUDGE KARLIN: And if it does approve that BWR VIP-139, then what happens?

MR. ROWLEY: Then the Applicant will use that as its aging management program.

JUDGE KARLIN: Okay, and if staff doesn't approve it, then what happens?

MR. ROWLEY: They will still continue the steam dryer monitoring plan that they currently --

JUDGE KARLIN: Okay, so the current one that applies is the steam dryer monitoring plan revision 3?

MR. ROWLEY: Yes.

JUDGE KARLIN: And that is going to apply for the next 20 plus years unless some event happens in the future?

MR. ROWLEY: Correct.

JUDGE KARLIN: So let's focus on that and the testimony, well, let me ask on the steam dryer monitoring plan. Let's go to page four and five of the testimony, pre-filed, and there apparently are some conditions you refer to on page five? License condition five specifies that there are in each of the three scheduled refueling outages, a visual inspection shall be conducted?

MR. ROWLEY: I think Mr. Scarbrough can answer that.

JUDGE KARLIN: Well, no. Why are one of you talking about one and the other --

MR. SCARBROUGH: The reason that I was involved with the power uprate review and that's where the licensed conditions were placed in the license amendment for the power uprate, and this was part of the condition for the steam dryer monitoring plan and the license renewal was a different renewal.

JUDGE KARLIN: Well, you did the uprate. and this is the license renewal. So we're talking about the license renewal?

MR. SCARBROUGH: Yes, what was done in the power uprate we carried forward. That was already reviewed. We do the review for that since this is so recent, we just carry it forward, and it will carry forward in the licensing renewal.

JUDGE KARLIN: Okay. So Mr. Scarbrough, you did the EPU, steam dryer monitoring plan?

MR. SCARBROUGH: That was part of our review.

JUDGE KARLIN: Part of your review. Perhaps you can help us with the testimony. What is the steam dryer monitoring plan revision 3 that was approved under the uprate call for?

Let me go to page four of your testimony or the testimony and see if it was yours -- yes, that was your testimony.

And I quote, "in its SDMP Entergy stated that the Vermont Yankee steam dryer would be inspected during refueling outages scheduled for the fall of

2005, spring of 2007, fall of 2008, and spring of 2010, in accordance of recommendations of GE SIL 644," right?

MR. SCARBROUGH: Yes.

JUDGE KARLIN: How many inspections is that?

MR. SCARBROUGH: Three. They can do three as part of the requirement of the license conditions of the power uprate. After the first three outages afterward, they would do those inspections.

JUDGE KARLIN: Well, actually that's four. Fall of 2005, spring 2007, fall 2008, spring 2010. That's four.

MR. SCARBROUGH: Fall '05 was before it was issued.

JUDGE KARLIN: So there's three scheduled and so on page five when you refer to -- for example, license condition 5 specifies that during each of the three scheduled refueling outages beginning, blah, blah, blah, a visual inspection shall be conducted."

Right? Those are the three scheduled outages you're talking about?

MR. SCARBROUGH: Yes.

JUDGE KARLIN: Condition 5 is a condition, imposed condition of this license or or the EPU?

MR. SCARBROUGH: It's the power uprate.

JUDGE KARLIN: Okay. And license condition 6 specifies the results of the visual inspection during the three scheduled refueling outages shall be reported. Again, that's under the EPU and the three scheduled outages and in 2010, right?

License condition 7, later on that page, it says, "license condition 7 specifies that the requirements for meeting the SDMP shall be implemented upon issuance of the EPU and shall continue until the completion of one full operating cycle at EPU conditions."

Does that mean that the obligation to do the inspection terminates after the completion of one full operating cycle?

MR. SCARBROUGH: After they complete that third outage, that third inspection in 2010, what we are trying to do is come up with a sunset provision in the license condition so that eventually these conditions would merge into a longer term program.

JUDGE KARLIN: Okay.

MR. SCARBROUGH: Part of what they also are part of this license condition provision is the commitment or the license condition that they implement the GE SIL service information letter, 644, rev. 1.

JUDGE KARLIN: Yes.

MR. SCARBROUGH: And that has a long-term program beyond the power uprate, so this -- once they performed the inspections of the three after power uprate and assuming and those conditions in that they do not see any significant issues --

JUDGE KARLIN: Right.

MR. SCARBROUGH: Then this would sunset out and then they would be into long-term GE recommendation for whatever they decide in terms of the GE recommendations. And this is 644 and currently in 644 --

JUDGE KARLIN: Now let me stop you there. So these are the visual inspections, right?

MR. SCARBROUGH: Yes.

JUDGE KARLIN: And the GE 644 is the monitoring of plant parameters?

MR. SCARBROUGH: Actually, they're both.

JUDGE KARLIN: Okay, but let me just focus on this. I'm just concerned. License condition 7 of the uprate says that the duty of Entergy to do these visual inspections, as I read this, terminates after the completion of one full operating cycle if everything is fine for that one cycle. At 2010, they're done. They don't have to do any more visual inspections under the EPU.

MR. SCARBROUGH: No, they do, because there's a license condition here for SIL 644.

JUDGE KARLIN: Okay.

MR. SCARBROUGH: And SIL 644 is a long-term GE recommendation and SIL 644 says they inspect eery other outage --

JUDGE KARLIN: Where does it say that in this -- where does it say that, that they will do that during the period of extended operations?

MR. SCARBROUGH: It's in Exhibit -- the GE SIL 644 with exhibit -- I don't know the number.

JUDGE KARLIN: Well, I have GE 644, but what I want is the permit condition that says they're going to be obliged to do that during the next 20 plus years.

MR. SCARBROUGH: That is the commitment to continue --

JUDGE KARLIN: Well, let's go to the commitment. It doesn't say that. Let me see. Let's go back to what the commitment says.

MR. SCARBROUGH: They're going to continue to do the steam dryer monitoring plan.

JUDGE KARLIN: Right, and the steam dryer monitoring plan, if they do -- they can do that. If I was Entergy I would say I'll do three of them and I've just complied with the steam dryer monitoring plan.

MR. SCARBROUGH: The steam dryer monitoring plan incorporates 644. It doesn't say here in the commitment, but we know what the steam dryer monitoring plan uses GE SIL 644.

JUDGE KARLIN: Well, commitment 37 doesn't say anything about SIL 644, does it, Mr. Rowley?

MR. ROWLEY: No, it does not.

JUDGE KARLIN: Let's go -- there's another provision that might. Let's go to FSER Section 1.7 on page 112.

That's a summary of proposed license conditions, right? And it says the third license condition, "the third license condition requires the implementation of the most recent staff approved version of the boiling water reactor vessels and internal project integrated surveillance program as the method to demonstrate compliance of the requirements of" blah, blah, blah, 10 CFR Part 50.

It doesn't say anything about SIL 644. What I'm trying to find is the mention in the FSER, the mention in exhibits here today that say Entergy will do the -- continue to do visual monitoring after the 2010.

MR. ROWLEY: I'm trying to find it in the aging management program that you -- we put it in there. It's not specific in the commitment.

JUDGE KARLIN: Let's go to the aging management plan review. 3.174 of the FSER is the section I found. Maybe there are other sections.

Maybe it's in there. It's pretty short. It shouldn't take as long. Where does --

MR. ROWLEY: What page are you on, sir?

JUDGE KARLIN: Page 3.174 of the FSER.

(Pause.)

MR. ROWLEY: That's one location where we talk about the FE-139.

JUDGE KARLIN: It says Section 3.1.2.1.6 of the FSER, cracking due to flow-induced vibration and it discussed in the discussion column blah, blah, blah, the Applicant stated that BWR vessel internal program will manage cracking in the stainless steel steam dryers."

I see that's a will. Obviously, the BWR VIP program 139 isn't even in existence yet. So that couldn't be working.

MR. ROWLEY: The draft is up for approval.

JUDGE KARLIN: Okay, well, let's talk about the draft. What is the BWR VIP? What is that?

Who is most familiar with the BWR VIP?

Mr. Scarbrough, thank you.

MR. SCARBROUGH: It's a group, the BWR owners group. It's a project that the BWR owners group has in place to look at all internal aspects of the reactor vessel. They do reviews of loose parts evaluations and they prepare guidance documents for the boiling water reactors.

And the staff has interactions with them on a regular basis for what their projects are. And one of the areas that they're developing is that the BWR VIP 139 and that's one of their projects, where they're looking at the whole history of steam dryer issues in terms of the experience they've had with them, what are some of the areas of recommendations in terms of evaluating the stresses and the loads in the dryer, talking about the --

JUDGE KARLIN: Okay, the operative words it's an industry group?

MR. SCARBROUGH: Yes.

JUDGE KARLIN: Does it involve the public? The members of the public like Dr. Hopenfeld?

MR. SCARBROUGH: We do have meetings with them, they are public. We do have public meetings with them.

JUDGE KARLIN: Is there a copy of the BWR VIP-139 as an exhibit in the record here?

MR. SCARBROUGH: I do not believe it is.

JUDGE KARLIN: There's a lot of references to that in the testimony and in the FSER. I kept looking for it, saying oh, this must be an important document. We better look at it and see how good it is. Is it in here?

MR. SCARBROUGH: No, I mean --

JUDGE KARLIN: You are the staff who reviewed this. Any of the parties, is there an exhibit that's -- yes, Mr. Lukens?

MR. LUKENS: Your Honor, VIP-139 was submitted in discovery. However, it was not submitted by Entergy as an exhibit. I do have a copy of it.

JUDGE KARLIN: All right. Well, I'm not surprised you would have a copy of it, but this is good, but it's not an exhibit. It's not in the record here. So I guess we can't look at it or understand what it says.

MR. ROWLEY: Your Honor, if I could, could I have you turn to page 3.26 of the SER, Section

3.0.3.2.7.

JUDGE KARLIN: What page, 3-56?

MR. ROWLEY: 3-56. This is where you see -- if you go to the last paragraph on that page, talk about commitment 37 and that they're going to do the steam dryer monitoring plan revision 3 and set these inspections , incorporating the guidelines of the SIL so that tells there. It wasn't in the commitment in the Appendix A that the SIL was going to be a part of the monitoring plan, but here in the evaluation for the vessel in terms of the program. We state that.

JUDGE KARLIN: In a letter dated, 3.56 says "in a letter dated August 22, 2006, the Applicant committed commitment 37 to continue inspections in accordance with the VYNPS steam dryer monitoring plan revision 3." Is that what you're referring to?

MR. ROWLEY: Yes.

JUDGE KARLIN: These inspections incorporate the guidelines of GE SIL 644 rev. 1 in accordance with existing procedures.

Okay, so continue inspections in accordance with the steam dryer monitoring plan rev. 3. Didn't we just read that the steam dryer monitoring plan rev. 3 says inspections can end as soon as you get a full cycle?

MR. ROWLEY: That was for EPU purposes but the commitment is to continue that for license renewal.

JUDGE KARLIN: It says continue it in accordance with the steam dryer monitoring plan. And if I'm Entergy I can say I just completed the steam dryer monitoring plan. I've complied. I'm done.

MR. ROWLEY: The plan is the same, almost the same as the program that's there for them to use. But it doesn't have to stop. It's a continue --

JUDGE KARLIN: It doesn't have to stop, but it says it can stop. If Entergy -- it seems to me they could fully comply with the steam dryer monitoring plan and this commitment by saying we have gone through one full cycle. The steam dryer monitoring plan says we can stop. We're stopping. We just complied with the provision that said all we need to is comply with the steam dryer monitoring plan.

MR. ROWLEY: The license conditions for EPU says that they can stop in 2010 for the plan, but the plan will continue on in license renewal. The plan is nothing that stops -- the condition says they can stop using the plan.

JUDGE KARLIN: They continue in accordance with the steam dryer monitoring plan and steam dryer monitoring plan says they must continue until they go through a full cycle of when they're clean and then they can stop.

MR. ROWLEY: The license condition says they use the plan through 2010. But the plan doesn't stop --

JUDGE KARLIN: Well, I think it's a legal matter and I'm troubled by the fact that this is -- I can read that and I do read that as calling for -- allowing Entergy to call visual inspections. I think maybe some additional clarity at the minimum is needed on that because it would allow them to stop monitoring, stop visual inspections in accordance with the steam dryer monitoring plan as soon as they have a full clean cycle. And any good lawyer could say that's the way it's interpreted. I understand that may not be what you intended.

Let me focus on page 11 -- I'm sorry, 10 on the questions for the Entergy witnesses. E3-01, Exhibit - -this was previously an exhibit, your testimony. A question, number 21 on what was page 10.

Question: Please describe the Aging Management Program for the steam dryer included the Vermont Yankee license renewal application.

And you quote the Applicant saying

"cracking due to flow-induced vibration in stainless steel steam dryers is managed by the BWR vessel internal program. BWR vessels internal program currently incorporates" -- now is that the steam dryer monitoring plan?

What is the plan? I'll ask Mr. Lukens, I guess. What is the currently committed to license in the license renewal application of what you're going to do to manage the aging of the steam dryer?

MR. LUKENS: Our current commitment in the license renewal process is to continue the inspections and monitoring specified in GE SIL 644. And GE SIL 644 does not run out at some point after power uprate. The ongoing reinspection criteria in GE SIL 644 for uprated plants is a full inspection of all susceptible accessible areas at least once every two refueling outages.

JUDGE KARLIN: Okay, can you show me that?

MR. LUKENS: Yes, sir.

(Pause.)

Exhibit E3-09.

JUDGE KARLIN: Please identify what that is.

MR. LUKENS: It is GE SIL No. 644 rev. 2 entitled BWR steam dryer integrity.

JUDGE KARLIN: All right.

MR. LUKENS: And appendix D --

JUDGE KARLIN: D as in dog?

MR. LUKENS: Yes, sir. Which is on page 30 of the document.

JUDGE KARLIN: I'm with you.

MR. LUKENS: Is entitled monitoring guidelines.

JUDGE KARLIN: All right.

Now let me ask you on this monitoring guidelines, is this monitoring of the plant parameters?

MR. LUKENS: Yes, sir. It is.

JUDGE KARLIN: Is it visual inspection? As I understand it, your plan consisted of two major components? One, monitoring of plant parameters on a continuous basis and the other is visual inspections at each refueling outage.

MR. LUKENS: That is correct.

JUDGE KARLIN: Is Appendix D only the monitoring on a continuous basis?

MR. LUKENS: Yes, that's my understanding.

JUDGE KARLIN: Okay, Appendix D doesn't include the visual inspections?

MR. LUKENS: That's correct. It is in

Appendix C, Charlie, which is on page 15.

JUDGE KARLIN: Okay, page 15, Appendix C, inspections.

MR. LUKENS: I've seen this within the last 48 hours.

JUDGE KARLIN: All right. I see it calls for a number of criteria with regard to inspections and some recommendations. Is there -- maybe there is an integral there that says every outage or every second outage --

MR. LUKENS: I apologize for the confusion, Your Honor. If I could direct your attention to pages 6 and 7 of the SIL.

JUDGE KARLIN: All right.

(Pause.)

JUDGE KARLIN: I didn't find it, but it might be in there.

MR. LUKENS: Page six, the second column is entitled recommended actions. Letter A is for all plants.

JUDGE KARLIN: Repeat the visual inspection of all susceptible locations at least once every two refueling outages. Is that -- that's unquote, right?

MR. LUKENS: That's correct.

JUDGE KARLIN: Okay, so that's Entergy's commitment.

MR. LUKENS: It goes beyond that, sir. On page seven, Section B as in bravo, says "in addition for plants planning on increasing operating power level above original license thermal power" and that would be Vermont Yankee, "the recommendations presented in A above should be modified as follows" and this is where it describes the baseline inspection.

JUDGE KARLIN: Yes.

MR. LUKENS: And repeating visual inspection during each subsequent refueling outage the wording is not identical to our commitment for three consecutive outages, but it does say until at least two full operating cycles at the final uprated power level have been achieved and that turns out to be three consecutive refueling outages.

JUDGE KARLIN: Well, okay. So all right. I have some questions about that, but I guess let me see if I understand you. You're saying that Entergy has committed to monitor in accordance with the - -do the visual inspections in accordance with this appendix C of SIL 644 on this frequency.

MR. LUKENS: That is correct.

JUDGE KARLIN: Okay. And this frequency would consist of -- is not consistent -- is it consistent with what was said in the refueling outage?

MR. LUKENS: I haven't heard anything inconsistent, Your Honor.

JUDGE KARLIN: Okay.

MR. LUKENS: The commitment is --

JUDGE KARLIN: Where is that commitment? Where is the commitment in the FSER, it he license condition, in the commitment 37 that says that this will be followed? Can I find it? And maybe the staff can help me.

MR. ROWLEY: Commitment 37, it doesn't say anything more specific than that. They will continue to use the SIL 644, the directive on page 3-56 of the SER. That's --

JUDGE KARLIN: Well, having said something in the SER doesn't make it legally binding, does it? It's not a commitment.

MR. ROWLEY: Well, a commitment --

JUDGE KARLIN: It's not a license condition.

MR. ROWLEY: There's a license condition in Section 1.7 that says that the commitments are going to be put into the FSER and FSER updated for that renewal period.

JUDGE KARLIN: Well, isn't the license condition of 1.7 of the FSER talking about the BWER VIP 139?

MR. ROWLEY: Right --

JUDGE KARLIN: That's not what this is.

MR. ROWLEY: No. The other commitment, I think the first and second one on that page talks about them having to update the UFSAR.

JUDGE KARLIN: Yes.

MR. ROWLEY: That's where these commitments will be -- have to put into the UFSAR.

JUDGE KARLIN: Wait a second. So let's go to that. "The first license condition requires the applicant to include UFSAR supplement required by 10 CFR 54.21D and the next UFSAR update as required by Sections such and such."

Is that what you mean?

MR. ROWLEY: Right. These commitments --

JUDGE KARLIN: No, no. That's what we're supposed to find that there's a commitment that they will do visual monitoring on this basis?

MR. ROWLEY: No, the commitment is there in Appendix A which lists all 51 commitments of --

JUDGE KARLIN: But Appendix A doesn't

refer to SIL 644. Does it?

MR. ROWLEY: Well, it's tied in commitment 37, says they're going to continue to do monitoring plan, and we know that the monitoring plan incorporates GE SIL 644.

JUDGE KARLIN: Who knows? Who knows? Does NEC know? Does the Board know?

MR. ROWLEY: You have to look at the Commitment 37 as written and go to the aging management program, Section 3 page 3-56 to get the complete story. My oversight, when we put that commitment together to include those words that said they would continue, but it is there in SER.

JUDGE KARLIN: The fact that there is something state in the SER does not make it legally binding. It is not a legal commitment. It's not a commitment. It's not a licensed condition. It's a statement. In fact, Judge Ferrar, just recently had a case where the staff specifically took the position because it's in the FSER does not make it binding at all. So anyway, I'll move on.

Let us go back to Mr. Lukens and Mr. Hoffman, and look to your testimony about the BWR VIP-139. Now as I understand the idea is that for the time being, the steam dryer monitoring program, Rev 3, which was approved under the uprate, will be monitoring the management program for the steam dryer to the end of time, unless this contingency occurs, right?

Now let's look at this: "Vermont Yankee will evaluate BWR VIP-139 once it is approved by the staff and either include its recommendations in the VYNPS BWR, vessels improvement ground, or inform staff of the YYNPS's exceptions to that document. Is that what's going to happen when BWR VIP-139 comes out and is approved?

MR. LUKENS: Yes, is it. The BWR VIP-139 incorporates the SIL requirements as additional backup technical material, it looked like the SIL was maybe 20 some-odd pages. The VIP document was on the order of 200 pages.

JUDGE KARLIN: So the BWR VIP-139. Let's think about the things that have to happen. First, the staff has to approve it, right?

Is that right, Mr. Scarbrough?

MR. LUKENS: If I may, Your Honor.

JUDGE KARLIN: Yes?

MR. LUKENS: The BWR VIP Program sponsored by EPRI has been committed by the entire BWR industry to NRC and is part of our current licensing basis.

BWR VIP-139 was issued in 2005 and we --

JUDGE KARLIN: What do you mean issued? BWR VIP --

MR. LUKENS: Issued by EPRI and therefore incorporated into our current licensing basis as part of our requirement for dryer inspection.

JUDGE KARLIN: So EPRI is the Electric, Edison, Electric --

MR. LUKENS: The Electric Power Research Institute.

JUDGE KARLIN: And EPRI is the entity that previously in this proceeding refused to allow NEC to look at the documents? Okay, so EPRI and the industry put together BWR VIP-139?

MR. LUKENS: That's correct.

JUDGE KARLIN: Is it a public document that we can see?

MR. LUKENS: It is proprietary.

JUDGE KARLIN: So it's not public document?

MR. LUKENS: That's my understanding.

JUDGE KARLIN: Nobody can see it except the industry.

MR. LUKENS: That's my understanding.

JUDGE KARLIN: And it was developed by the industry and it's been submitted to the NRC, is that correct?

MR. LUKENS: Yes.

JUDGE KARLIN: And New England Coalition and no one else has seen it? Now, it's under review by the Agency. Is that correct, Mr. Scarbrough?

MR. SCARBROUGH: Yes, it is.

JUDGE KARLIN: And are you part of the review team?

MR. SCARBROUGH: Yes, I am.

JUDGE KARLIN: And when do you expect to make a decision on approval or not approval?

MR. SCARBROUGH: I think some time this year. I think it's in the final stages.

JUDGE KARLIN: And in the approval process, is there some time an iterative process where the NRC will ask for changes?

MR. SCARBROUGH: Right, yes, and we have sent out requests for this new information as part of that. And part of that review was the BWR 139 document referred back to the SIL for 644 for guidance in times of repetitive visual inspections and that sort of thing, so one of our questions was, you know, what -- explain that, and they sent answers back in on that --

JUDGE KARLIN: Okay, my point is is that there is an iterative process going on between the industry and NRC on BWR VIP-139?

MR. SCARBROUGH: Yes, there is.

JUDGE KARLIN: And no member of the public is part of that iterative process.

MR. SCARBROUGH: We have had public meetings, and when we meet, we have public meetings --

JUDGE KARLIN: Are they able to see the RAIs that you send out?

MR. SCARBROUGH: I believe that they are.

JUDGE KARLIN: Are they able to see the BWR VIP-139 that the RAI is about?

MR. SCARBROUGH: I would have to ask --

JUDGE KARLIN: I'm not surprised --

MR. SCARBROUGH: I would have to ask the management --

MS. BATY: Your Honor, if we had an opportunity to check, there may be a non-proprietary version of that.

JUDGE KARLIN: You can check all you want. We'll be within your --

MS. BATY: Yes, I just wondered if we could have an opportunity after lunch to check?

JUDGE KARLIN: Okay, so there's iterative process going on between industry and NRC. The BWR VIP-139 may evolve during that process or change in some way. But one that we haven't seen. And this Board hasn't seen.

And at some point the staff may or may not decide to accept BWR 139, right?

MR. SCARBROUGH: Right.

JUDGE KARLIN: So there's a contingency, one, will the staff accept BWR-139?

There's another contingency will BWR VIP-139 change between now and when the staff accepts it. Do you agree, Mr. Scarbrough?

MR. SCARBROUGH: Yes.

JUDGE KARLIN: And then there's another contingency, as I read this, Mr. Lukens, which is when BWR VIP, once it is approved by the staff, then Vermont Yankee will evaluate it.

MR. LUKENS: Yes, sir.

JUDGE KARLIN: And then you'll decide whether you want to adopt it.

MR. LUKENS: May I explain?

JUDGE KARLIN: No, let's read this.

MR. LUKENS: That's what it says.

JUDGE KARLIN: Vermont Yankee will evaluate BWR VIP-139 once it is approved by the staff and then you get -- you decide whether you want to use it. It's not a commitment to use it if the staff approves it. It's a commitment to use it if the staff approves and you decide you want to use it. Right?

MR. LUKENS: Not exactly, sir.

JUDGE KARLIN: Okay.

MR. LUKENS: VIP-139 is part of our current licensing basis. NRC approval of VIP-139 may include certain conditions or limitations that go beyond the requirements of VIP-139.

Regardless of --

JUDGE KARLIN: I'm sorry, what may --

MR. LUKENS: The staff approval of VIP-139 may include conditions or limitations on certain sections of VIP-139.

Since we don't know what those might be, this wording simply says we have to look at any conditions or limitations to determine whether it is possible for us to meet this.

JUDGE KARLIN: So what we have is staff may or may not approve it. Staff may or may not impose conditions on it and if staff imposes any conditions on it or any -- it doesn't say. You can decide whether you want to use it or not.

MR. LUKENS: We cannot decide whether we

want to use it or not.

JUDGE KARLIN: Well, it says "Entergy will evaluate BWR VIP-139 once it is approved by the staff and either include its recommendations in the BWR Vessels Improvement Program, or inform the staff of Entergy's exceptions to the document", right?

MR. LUKENS: That's correct.

JUDGE KARLIN: So you don't like it, you don't have to agree with it?

MR. LUKENS: No, sir. That's not true.

JUDGE KARLIN: Well, you either agree to it or you say no, we have exceptions.

MR. LUKENS: We may take exceptions to additional conditions or limitations that the staff may impose above the requirements of VIP-139, but we are required --

JUDGE KARLIN: I thought we just heard it was an iterative process and VIP-139 isn't a done deal until they get finished negotiating with the NRC about it?

JUDGE WARDWELL: Let me ask a question to help clarify this for me.

I think it was Mr. Hoffman or Mr. Lukens about a half an hour ago stated that the VIP-139 was issued and is filed as of 2005. Is that correct?

MR. LUKENS: That is correct.

JUDGE WARDWELL: So there is not a draft of VIP-139 floating around. 139 is a final document issued by EPRI, is that correct?

MR. LUKENS: Yes, it is.

JUDGE WARDWELL: And you're stating that that's part of your current licensing basis?

MR. LUKENS: That is correct.

JUDGE WARDWELL: So you are obligated to continue that under your current licensing basis?

MR. LUKENS: That is correct.

JUDGE WARDWELL: Is that going to be extended, is there commitment to extend that in regards to the license renewal?

MR. LUKENS: The program of BWR Vessel Internal Program sponsored by EPRI is an on-going process for the life of the plant, yes. That will be an on-going process.

JUDGE WARDWELL: The only thing you're couching here is the phrase "its recommendations" which refer back to staff's recommendations of what they might have in regards to their review of the current final 139 document?

MR. LUKENS: That is correct.

JUDGE WARDWELL: Thank you.

JUDGE KARLIN: Well, that's really -- I'm not sure really that's what it says. That may be your intent, but to me it seems to say you will evaluate the BWR VIP-139 once it is approved by the staff and either adopt it or tell you, the staff, you have exceptions to it.

Now let me go on on page 11, you start, Mr. Lukens, in your testimony, pre-filed anyway, on question 24, and answer 24, the dryer monitoring program and you describe the dryer monitoring program in the next few pages of testimony.

Is that the steam dryer monitoring program, rev. 3 under the EPU or is that the steam dryer monitoring program under BWR VIP-139?

What are you describing here?

MR. LUKENS: We are describing steam dryer monitoring program revision 3 that was implemented during EPU and that will continue for the life of the plant.

JUDGE KARLIN: So this is not BWR VIP-139?

MR. LUKENS: No, sir.

JUDGE KARLIN: We don't know what that is? The Board Members have no idea what that is. Is that correct?

MR. LUKENS: Yes, sir.

JUDGE WARDWELL: Is that proprietary too. Is that why we don't have that as an exhibit?

MR. LUKENS: It is proprietary, yes.

JUDGE KARLIN: And even if there's a nonproprietary version of it, we don't have it, one way or the other, so we can't base a decision on it, I think. But I just want to know when you're talking, I think it's important for us to know as we go on with this contention, when you're describing the plan, there seems to me to be two plans that are floating here. One is the what I'll call existing steam dryer monitoring program rev. 3 that was approved under the uprate and you all would interpret will continue under the renewal. And I understand it will versus the BWR VIP-139 and when we ask questions what are you going to do, how is it going to work, how will it be conducted? I think it's important for us to know which one we're talking about and which one you're talking about. It seems to me the only one that makes any sense here for us today is the steam dryer monitoring plan, rev. 3 that's under the EPU because the BWR VIP-139 is a pig in a poke. We haven't seen it. We don't know what it is. It may not be approved by the staff. It may not be accepted by Entergy. And it's just an absolute blank box that we cannot evaluate or understand.

So when you testify, hopefully, you will tell us which one you're talking about and presumably the only one that is of relevance here today is the one that's on the table right now which is the SD, steam dryer monitoring plan rev. 3.

JUDGE WARDWELL: And what is that though? Isn't that as much a black box? We don't have that before us either, do we?

MR. LUKENS: I'm sure we have. It is an exhibit.

JUDGE WARDWELL: Okay. I thought you said it wasn't. The steam dryer monitoring plan rev. 3 is an exhibit.

JUDGE KARLIN: Okay.

JUDGE WARDWELL: And how does that relate to 139? 139 was final at the time that was written.

MR. LUKENS: That's correct. The steam dryer monitoring plan is based on SIL 644 as it applies to monitoring an inspection. The currently issued VIP-139 does not contain pre-inspection criteria.

The inspection guidelines in the two documents are identical, but currently VIP-139 does not contain reinspection criteria. SIL-644 contains those reinspection criteria as I indicated on pages six and seven of the SIL. And SIL-644 applies to uprated plants.

So the difference between the SIL and VIP-139 is that for uprated plants the SIL contains additional reinspection criteria that are not VIP-139.

JUDGE WARDWELL: Let's take the other option then, what happens if, in fact, staff approves it, doesn't have any recommendations, so it's fine the way it is. We're off and running with now VIP-139 controlling. Where does the SIL come back into play in regards to assuring there's continual inspections?

MR. LUKENS: Perhaps Mr. Scarbrough can address how the SIL is incorporated into the current VIP-139 that's before the staff.

JUDGE WARDWELL: I don't care about that. I'm more interested in how does a SIL get incorporated in the aging management plan proposed for license renewal, if in fact, the 139 is approved prior to even issuing the license for this?

MR. SCARBROUGH: Yes, and that's part of the issue with BWR VIP-139 is that the issue now just refers back, it doesn't have those reinspection forms so that's something that we've been interacting with BWR with about and their proposal in the BWR VIP-139 for that document is different. They have a more graded approach. It is a different approach, so that would have to be reviewed as part of the switch over. If they're going to switch over -- if the entity is going to switch over from SIL 644 to BWR 139, the inspection, reinspection forms are different. Right now, the issue version from what I understand don't have any, but the new version --

JUDGE KARLIN: So let me stop you right there. BWR VIP-139 doesn't have any visual inspection forms, is that what you just said?

MR. SCARBROUGH: The ones on the street right now --

JUDGE WARDWELL: The one that they issued, the one that Entergy is hanging its hat on doesn't have any inspection requirements.

MR. SCARBROUGH: Reinspection, and that was one of the questions we asked them. And the answer --

JUDGE WARDWELL: And if you decide you want to impose that as a condition, then Entergy says we reserve the right to object to that and not adopt it.

Is that right, Mr. Lukens?

MR. LUKENS: No, sir.

JUDGE KARLIN: So tell me what's right.

MR. LUKENS: If the staff says we want uprated plants to continue with the guidance of SIL 644, then the transition from steam dryer monitoring plan to VIP-139 is seamless. We just keep doing what we're doing.

JUDGE KARLIN: Wait a second. But you don't have to. You just said you didn't have to. You weren't going to agree to it.

Might agree, might not agree. But it's an opportunity for you to make a decision.

MR. LUKENS: SIL 644 reinspection requirements are part of our current licensing basis for the remainder of the plant life.

JUDGE KARLIN: But they are not part of BWR 139, VIP-139. BWR VIP-139, if approved by the staff as is, you won't have to do any of those inspections.

MR. LUKENS: Yes, sir, we --

JUDGE KARLIN: You might do it voluntarily.

MR. LUKENS: We still will be obligated under our licensing basis to perform reinspections to SIL-644.

JUDGE KARLIN: I don't understand. Let me look at --

JUDGE WARDWELL: Let me ask you this then just to clarify that. Is it correct then that you're saying that all of your current licensing bases that doesn't relate to -- all of your current licensing bases have to be followed for the extended period of operations for the renewal, unless it's modified by the license renewal itself?

MR. LUKENS: That is my understanding, but I'm not a licensing engineer.

JUDGE WARDWELL: Mr. Scarbrough, do you have any knowledge or anyone from the staff, Rowley or Hsu?

MR. SCARBROUGH: I'm sorry, could you repeat the question?

JUDGE WARDWELL: Yes, the question is Mr. Lukens said that SIL is part of their current licensing basis so he was using that as the support for the fact that the ongoing inspections will continue regardless. And my question relates to do all of the current license bases follow through and now exist for the extended period of operations unless modified by the license renewal process?

MR. SCARBROUGH: My understanding in terms of like a GE service letter, it's a recommendation for

BWR plants to implement some activity based on the knowledge of EEH and SIL 644 is that service information letter. It says you have a piece of equipment and these are the actions we recommend you perform.

My understanding is is those plants are obligated to respond to those recommendations. They have to either implement them or have a reason why they're not implementing them and our expectation is that if there's SIL 644 out there which says you will do this, they are expected to do that or have a justification for why not.

JUDGE WARDWELL: Mr. Rowley?

MR. ROWLEY: One of our key principles of the license rule is that the current license will carry forward into the renewal period.

JUDGE KARLIN: But on page 5 of your testimony, Mr. Scarbrough, at the bottom you say "if BWR VIP-139 is approved, prior to the period of extended operation Entergy would convert to BWR VIP-139 guidelines from the GE SIL 644." This is telling me it's an either/or. You're saying they wouldn't do 644 any more. They would do this BWR VIP-139.

MR. SCARBROUGH: In terms of the guidelines, the BWR VIP-139 is much more extensive in terms of the information that they provide.

JUDGE KARLIN: I'm not looking for guidance. I'm looking for permit conditions that are enforceable by NRC. And are you saying 644 is gone and BWR VIP-139 comes into place in lieu thereof?

MR. SCARBROUGH: In terms of the license renewal that was their request, that they have the option to switch over --

JUDGE KARLIN: They have the options.

MR. SCARBROUGH: Yes. And the intent would be that BWR VIP-139 has more information and that there are some areas in it where it recommends additional inspections in terms of the guidance based on lessons learned since it was issued. So there are some places where it actually adds additional inspection areas of the dryer. So there are some improvements in the latest versions because they have been responding back in those issues and in March of '05 they've been responding back to questions that have taken place that they're going to upgrade it and improve it as they go by. But this is a statement saying that this was our understanding of the actions that will take place --

JUDGE KARLIN: It wasn't saying it was your understanding, it was your testimony under oath that that's what would happen.

MR. SCARBROUGH: Right, that was my understanding of what they would do. They would be converting over to --

JUDGE KARLIN: No, you're the regulator. Why don't you tell us what the regulatory -- what you're imposing. It sounds like that's what you're saying. If this happens, then A. If it doesn't happen, then B.

MR. SCARBROUGH: Right, our expectation would be that they would continue.

JUDGE KARLIN: All right.

JUDGE WARDWELL: Staff was required to make an assessment that -- let me back up quickly. We all agree that the steam dryer falls under aging management review. Do you agree?

MR. SCARBROUGH: Yes.

JUDGE WARDWELL: Entergy, do you agree with that?

MR. LUKENS: Yes.

JUDGE WARDWELL: There's a requirement that demonstrates that aging management is carried out for the life of the plant or if you have, in effect, demonstrated through aging management analyses as required, no one has brought up any TLAAs in this situation, so we're into developing an Aging Management Program for the steam dryer. Is that correct?

Do both parties agree to that?

MR. LUKENS: Yes.

MR. SCARBROUGH: Yes, sir.

JUDGE WARDWELL: What is in your understanding the Aging Management Program that Entergy is going to be implementing that you approved in regards to saying that it's adequate under as documented in the FSER?

MR. SCARBROUGH: I was not a party to writing the license renewal FSER, but in terms of the power uprate --

JUDGE WARDWELL: No, I'm -- okay, then I'm not interested in your testimony.

MR. SCARBROUGH: Okay.

JUDGE WARDWELL: Are either of you three able to address what is the Aging Management Program that the staff is approving as being a demonstration that the management of this particular component, the steam dryer, will be managed throughout the life of the plant?

MR. ROWLEY: At this moment, it is the steam dryer monitoring plan, revision 3, that incorporates GE SIL 644.

JUDGE WARDWELL: And where is that stated as their proposed Aging Management Program?

MR. ROWLEY: It's on page 3-56 of the SER, the Aging Management Program VIP, vessel internal program.

JUDGE WARDWELL: I can't refer to this right now off the top, quickly, but do they have any statements in their application stating that is their Aging Management Program for the steam dryer?

MR. SCARBROUGH: I can't recall exactly what the application says.

JUDGE KARLIN: Let me go to page six of the testimony of the staff. Question 4C. This is Mr. Hsu. Is that the correct pronunciation, sir?

MR. HSU: Yes.

JUDGE KARLIN: Hsu, and Mr. Rowley, "the staff finds the implementation of BWR VIP-139 acceptable because BWR VIP-139 will provide guidance for use of the latest methods and technologies," etcetera.

Are you with me there?

MR. HSU: Yes.

JUDGE KARLIN: Now this is the BWR VIP-139 that we haven't seen.

Mr. Scarbrough, it is your testimony that the staff is likely to take final action approving that within this year?

MR. SCARBROUGH: I believe so.

JUDGE KARLIN: And you're on the group that's reviewing that?

MR. SCARBROUGH: Yes, sir.

JUDGE KARLIN: So by the end of the year, the steam dryer monitoring program, rev. 3 that the staff has based its approval on will disappear and a whole different program will be applicable to this for the next 20 plus years.

MR. SCARBROUGH: I assume so.

JUDGE KARLIN: I mean there's a juncture coming which is the staff approval of BWR VIP-139. Until that juncture occurs, steam dryer management plan, rev. 3, is the one that they're committed to and you're suggesting there's approval upon when that juncture occurs, if the staff approves it, if Entergy decides to accept it, then a whole other program jumps into place, BWR VIP-139. Is this correct, Mr. Scarbrough?

MR. SCARBROUGH: Yes, it's a different program.

JUDGE KARLIN: And we don't know anything about it, this Board, this Intervenor. Is that correct?

MR. SCARBROUGH: Yes, sir. I assume so.

JUDGE WARDWELL: And let's go on. We do know something about it. We know it's not as rigorous in regards to the inspection program that the SDMP is.

MR. HSU: We are not sure right now because --

JUDGE WARDWELL: We're talking about what we're --

MR. HSU: The 139 of not being approved by the staff yet, okay, that's the BWR VIP-139 issuer. They're the issuer. But after -- and last year approved -- they're going to issue another version of the BWR VIP-139. They call it BWR VIP-139A which includes all the steps additional inspection, additional requirements and all the additional improvement in there. So that's all BWR VIP-139 is working on.

JUDGE WARDWELL: That's fine, if I can interrupt. I understand that. And that's fine, but that's a potential in the future. That's not reality.

MR. HSU: Yes.

JUDGE WARDWELL: You made a statement here at page six that Judge Karlin just quoted where you say the staff finds that the implementation of BWR VIP-139 acceptable because BWR VIP-139 will provide the guidance for use of the latest methods and technologies, yadda, yadda, yadda.

That statement was made I can say with confidence prior to any of the future implementation you've just described that may take place in the future. I've heard testimony today that the current 139 that you say is acceptable here does not include inspections in it. Is that correct?

JUDGE KARLIN: Mr. Scarbrough?

MR. SCARBROUGH: That's correct. It does not. It refers back to SIL 644. It indicates that there was not -- there was not reinspection requirements and that was one of our questions to EPRI that was -- and they refer back to 644 in their response to us.

MR. LUKENS: Your Honor, if I might clarify, the inspection criteria in VIP-139 are identical to the inspection criteria in SIL 644. The difference is VIP-139 as currently issued, does not have reinspection criteria. The SIL does have reinspection criteria.

JUDGE WARDWELL: Staff, how could you make the statement on page six that you find implementation of 139 acceptable without that reinspection criteria?

MR. SCARBROUGH: Our understanding was that in lieu of not having that the SIL 644 guidance would be followed. In terms of the reinspection because our discussions with BWR VIP was that they were not trying to set up the reinspection frequencies, but they were going to leave that to GE SIL 644. That was the plan. And the response to a question from us they said well, we're looked at the data and we're going to have a more graded approach. So their original plan was they were going to develop a later addition of 139 with all the data that they have from all the inspections of all the steam dryers.

JUDGE WARDWELL: You're repeating yourself. You still haven't answered my question.

How could you make the statement that the limitation of 139 is acceptable without that and all you're saying if I configure what you've said now is that you made that in the back of your mind you were thinking that's because SIL also would be incorporated in some way, but it's not documented or assured anywhere.

MR. SCARBROUGH: Yes, sir.

JUDGE WARDWELL: Mr. Lukens, what did you propose in your application as your Aging Management

Program for the steam dryer? If you could quote the page or reference in that application where you addressed this?

MR. LUKENS: In our testimony at page 11, the response to question 24.

The question is please describe the proposed steam dryer monitoring program.

JUDGE WARDWELL: I'm sorry, what page number?

MR. LUKENS: Page 11.

JUDGE WARDWELL: Okay.

MR. LUKENS: And answer 24 provides the description of the steam dryer monitoring program and at seven lines up from the bottom of that bottom paragraph, I'm sorry, this contains monitoring provisions. It apparently does not have the word inspection here.

JUDGE KARLIN: Well, let me try to help you there, Mr. Lukens. I think if we go to the preceding page, page 10, that's the one I was asking you questions about and the question is please describe the Aging Management Program for the steam dryer for the license renewal application and there you cite to section of the license renewal application 3.1.2.2.11 that we were talking about earlier.

MR. LUKENS: Yes.

JUDGE KARLIN: Check cracking due to flow-induced vibration is managed by the BWR's vessels internal program, whatever that is. The vessels approved currently incorporates GE SIL 644 and then we talk about the BWR VIP event in the future doesn't sound like it's very far in the future, end of this year, when a new plan can spring into place if you agree to it.

Is that -- so the current one is -- this is your testimony here, is it not?

JUDGE WARDWELL: So that is your aging management plan?

MR. LUKENS: Our aging management program today is SIL 644.

JUDGE KARLIN: And as you previously testified when I asked about page 11, 12, 13, when you describe your steam dryer monitoring program the description is what? The SDMP rev. 3 or the BWR VIP-139 and you said SDMP rev. 3. Is that correct?

MR. LUKENS: Correct.

JUDGE KARLIN: So this is not BWR VIP-139, what you're describing in answer to question 24, 25, 26?

MR. LUKENS: That's correct.

JUDGE KARLIN: Okay. So if we go back to FSER 3-175, let me ask this of the NRC staff, in this long document here, where does the FSER discuss the steam dryer Aging Management Program? I found the discussion at 3-174 to 3-175.

MR. ROWLEY: On page 3-56.

JUDGE KARLIN: Mr. Rowley has referenced us to 3-56. That was helpful. I understand there's a condition, commitment 37 in the appendix. And I understand that there's a reference on page 1.12 in the license conditions.

Am I missing discussion anywhere else in this long document? Is this where you discuss the steam dryer management program? Are there any other places where a more thorough discussion or any more details?

MR. ROWLEY: I have to get back to you on that one.

JUDGE KARLIN: Okay. We'll be taking a break here in a little bit. I mean I don't know if there is. I don't think there is. I'm not trying to trick you. I just didn't find it. And if there is, I'd like to read it and study it. But on page 3-175, it says staff finds that since the applicant committed to implement BWR VIP-139, if approved by the staff, this aging effect or mechanism will be adequately managed as recommended by GALL that Dr. Wardwell was questioning about.

In the alternative, "if the staff does not issue an SER approving BWR VIP-139, steam dryer inspections will continue in accordance with steam dryer monitoring plan rev. 3. The steam dryer monitoring plan would also assure the aging effects that the mechanism will be adequately managed. So the staff is saying either way, you're satisfied that the steam dryer aging management will be adequately managed. Is that right?

MR. HSU: Yes.

JUDGE KARLIN: All right, I think at this point we need to take a short break. Why don't we take a break for 10 minutes, if we would, please. In 10 minutes we'll reconvene. At this point, we're adjourned.

(Off the record.)

JUDGE KARLIN: All right, we will go back on the record, Mr. Reporter.

I will remind the witnesses you are still under oath, so please recognize that.

Now I think the NRC staff had a question that you might want to give us - did you find anything more on the FSER? Did you have enough time to do that?

Okay.

MR. ROWLEY: No, sir, those two locations.

JUDGE KARLIN: Those are the only locations? All right, fine.

All right, we will proceed.

Dr. Reed.

JUDGE REED: We're going to shift gears, and focus more specifically on the contention that NEC has brought forward, and just to refocus us, I'd like to ask Dr. Hopenfeld to remind us in hopefully a very few words exactly what the bone of contention is here.

Would you restate the contention three for us as succinctly as you can?

DR. HOPENFELD: The contention right now is based on an in-service inspection, and primarily moisture monitoring.

The contention is, the contention is that fatigue crack from high-cycle flow-induced vibrations cannot be monitored, but in-service inspection.

Also moisture monitor is up to the tap, and it's not reliable as an indicator of potential drier disintegration. It's the essence of it.

Am I loud enough?

JUDGE REED: No, that's fine. That's helpful.

Do you have something further to say?

DR. HOPENFELD: The issue is, disintegration of the drier that form new spots that can be carried into the steam lines or they can deform in some unanticipated places, and that you will interfere with the normal operation of the plant or abnormal operation, or DBA-designed accidents.

JUDGE REED: Okay, let's stop there.

Now you have stated in your testimony that public safety hazard will result if the drier was damaged in some -

DR. HOPENFELD: I can't hear.

JUDGE REED: You couldn't hear?

I'm sorry. I'll turn toward you and speak more clearly.

You had stated that a public safety hazard would result if the drier was damaged, and some of its parts broke loose and were transported by flow or gravity to other areas of the reactor system.

I think I've just restated what you said earlier?

DR. HOPENFELD: Correct.

JUDGE REED: So you agree with that

statement?

DR. HOPENFELD: Yes.

JUDGE REED: Would you explain in your mind how would these loose parts constitute a safety hazard?

DR. HOPENFELD: Well, I will give you the example that I remember from many years --

JUDGE KARLIN: I'm having trouble hearing you. Can we take a brief break right here? We might need to close the window.

(Whereupon, the matter went off the record briefly.)

JUDGE KARLIN: Go ahead, continue.

DR. HOPENFELD: Where the bathroom got breached, and got into the -- and blocked the flow channel of the fermium reactor. That's the extreme example.

We had many examples, in the case of BWRs in a steam generator.

JUDGE REED: What kind of reactor was the fermium reactor?

DR. HOPENFELD: It was a sodium-cooled reactor. It was a prototype.

JUDGE REED: Did it have anything to do with the steam drier?

DR. HOPENFELD: No. I'm just giving you the extreme case, asking what's possible in an extreme case. I can't visualize how it's going to get in there. In one extreme case the part can block the channel or block flow channels on the top. It's not the same reactor, no. The concept is the same.

Also in the case of the BWR steam generators, we had many situations where loose tar because of J-tubes forming part of coming down that would cause interference with the - causing tubes to vibrate, and causing them to wear out that led to steam generated tube rupture.

These are examples. I cannot anticipate -- you can premise about the infinite number of scenarios where safety functions would be affected. Flow parts could go in there and block the - or interfere with the safety relief valve. But you know I haven't looked at all the possibilities. This is some significant number.

JUDGE REED: So the two things that I heard that you were concerned with is the flow channel not be blocked, or that the safety release valve.

DR. HOPENFELD: I gave you an example. That's not what you heard. What I'm trying to say, it interfered with the safety functions of the system, of the reactor, during normal and abnormal operation. I gave you two examples, but just examples.

JUDGE REED: If the plant were shut down immediately following the generation of loose parts, do you still believe that there would be a safety problem or a hazard to the public?

DR. HOPENFELD: I couldn't answer that in either way, because I don't know. It depends on the particular situation. It depends on what happens during the shutdown due to SCRAM. I don't know. It depends where the parts are, or what is being blocked.

JUDGE REED: You are postulating these loose parts and suggesting it would be a safety hazard?

DR. HOPENFELD: Yes.

JUDGE WARDWELL: So why don't you give us an example of one where it would be a safety hazard immediately after a shutdown?

DR. HOPENFELD: Well, I gave you one, if for some reason a relief valve opens up, and it's supposed to open up during an accident, and it doesn't open up.

JUDGE WARDWELL: That's true with any accident that has something to do with the steam drier, isn't it?

DR. HOPENFELD: No, the steam drier is the source for loose parts in here. That's the purpose fo this whole contention.

JUDGE WARDWELL: So your testimony is that the loose part could get up into -

MR. FAIR: Oh, it doesn't - no, it doesn't have to come from the steam drier. It can come from some other place. The issue here is the steam drier that we found recently, because of the review, about three or four or five or six steam generators have developed cracks because of flow induced vibration, and parts went into places they shouldn't have been.

JUDGE WARDWELL: And it is feasible for a part from the steam drier to get to the relief valve?

DR. HOPENFELD: Probably, yes. I can't - I'd have to analyze it. It's feasible for any part from this fuel line, depends on what's the size, to get anywhere in the system.

JUDGE REED: Okay, you also stated a little more specifically in your testimony that, and I quote, loose parts may block flow channels in the reactor core; block spray cooling nozzles; or prevent the MSIVs from isolating the system during loss of coolant accidents.

You injected this idea of a loss of

coolant accident associated with loose parts. So are you postulating a LOCA associated with a steam drier failure?

DR. HOPENFELD: All I'm saying is there are certain basis action, steam rupture is one, major steam line rupture. Under that condition, because of the extra loads that you get associated - let me just back up. Under normal condition you have a pressure drop across that drier. That's one way,. In addition to this, you have acoustic sources which generate pressure forces which result in loads on the drier. During transients like LOCAs you have different type of forces. You have flow forces that additionally could impact the drier. You have large sources of energy that could further induce very large vibrations or resonance frequency on the drier.

Would you like me to give you an example? I'd be glad to. It's almost at firsthand. When the Turkey Point in Florida started up, it was heated up, a steam line broke or relief valve just blew up, the whole building, all the structures, were shaking up to about two to three minutes. There was a tremendous amount of energy released.

Now you have a drier that sits there and is just about to crack up, because it's already got cracks. When you have that kind of situation where a large energy release causes large amplitude vibrations on the drier, it will disintegrate, and it would interfere with the safety shutdown of the plant, or whatever you do in a particular situation to shut down the plant safety, to mitigate the accident.

And without going into the specifics of the accident, and the whole scenario exactly, I cannot go beyond this point. I can only give you general -

JUDGE REED: I would like to persist a little in understanding your concerns about a LOCA, since you introduced that in your testimony.

And I'm puzzled as to whether you believe that a failure of the steam drier would occur simultaneously with a LOCA?

DR. HOPENFELD: Yes.

JUDGE REED: Just by chance?

DR. HOPENFELD: No, it's not by chance.

JUDGE REED: So you think one causes the other?

DR. HOPENFELD: Yes.

JUDGE REED: Which causes which?

DR. HOPENFELD: The forces that are generated due to the LOCA, depends on what the LOCA is and where it is, whether it's a circulating line break, or is there a feedline break, or whatever it is.

JUDGE REED: So you are postulating a LOCA occurs, and that would cause a failure of the steam drier.

DR. HOPENFELD: Correct.

JUDGE REED: And then that failure of the steam drier then would cause some problem that would make -

DR. HOPENFELD: In mitigating the accident. You see when you have an accident -

JUDGE REED: Well, if had a LOCA, we kind of had the worst one.

DR. HOPENFELD: No, because you can have the LOCA some place, there are various procedures --

JUDGE REED: I'm trying to understand what your concern is.

DR. HOPENFELD: But you mitigate. And this is -- would be interfering. You say I introduce it? No, I believe it's in the regulation. I don't remember exactly where it is, where you are supposed to mitigate the components. I don't know exactly, 54 or something, the component is supposed to withstand normal operation and DBA operation.

JUDGE REED: Let me turn to the staff and ask is there any requirement to consider a failure of the steam drier in association with a loss of coolant accident?

MR. SCARBROUGH: No, sir, not that I'm aware of.

JUDGE REED: Could you repeat that?

MR. SCARBROUGH: No, sir, not that I'm aware of.

JUDGE REED: Is there any reason to believe that a LOCA could in fact cause failure of the steam drier?

MR. SCARBROUGH: When, as part of the power uprate, the licensee was required to locate at transients, and the load upon transients, from transients, including slowly vibration loads and the loads from brakes, relief valves opening, different things, they have to go through the transient evaluation and look at the stresses that would be on the drier. And that was part of the evaluation in terms fo power uprate, and the loads allowed under those types of conditions are greater than the loads allowed for normal operations of the steam drier because of fatigue. There is allowed to be degradation of the drier, some plastic deformation and things of that nature. So there are - the limits are there for higher than the normal loads that we would get from fatigue-oriented loads.

And so those - they did look at those, and they found that there was not situations where they would exceed the allowable loads made in the code. Even though this is not a code component, they followed those hints of guidance.

JUDGE REED: Can you envision a scenario in which the failure of the steam drier, some loose - generation of a loose part following a loss of coolant accident would exacerbate that accident, would make the conditions worse, or lead to a higher probability of core melt?

MR. SCARBROUGH: I'm not aware of - the examples that we had from Quad Cities failure, they had some loose parts. They ended up in various places. But there was not any situation where they caused a safety related component to not be able to perform its function.

JUDGE REED: so there was no LOCA?

MR. SCARBROUGH: Right, there was no LOCA.

JUDGE REED: I'm just following up on this introduction of the concept of a loss of coolant accident in association with the steam drier.

MR. SCARBROUGH: I'm not aware of what

might be a problem from that, because with the LOCA situation you are spraying water into the reactor, you are getting the pressure down, you are dropping pressure in certain flows. I'm not aware of what -- you would be trying to mitigate that event. And I'm not aware of what might be additional problems caused by a drier heat problem.

JUDGE REED: Is there in your mind any scenario by which a loose part from the drier could interfere with the injection of cooling water flow following a LOCA?

MR. SCARBROUGH: No.

JUDGE REED: Is that likely in your mind?

MR. SCARBROUGH: No, sir, I don't think it would interfere with the cooling water flow during the testing.

JUDGE REED: Dr. Hopenfeld, is there anything you would like to add?

DR. HOPENFELD: Definitely. First of all, I haven't seen, or they haven't provided us with an analysis as to what they have done, and I don't believe they have provided the Board with what kind of study they have done in the year or two in studying these things.

JUDGE REED: To study these things?

DR. HOPENFELD: Yes, to study the accident scenarios, to ask your question, the drier disintegrating and resulting in interfering with the mitigation of the accident.

I don't know what kind of study, they haven't presented to us any of these studies. But I concur from what the gentleman says that usually they are looking into the drier in perfect condition. When the drier is in perfect condition, you can see that if you put all those loads on it, it may stay in perfect condition.

But the issue here is we already you have a pre-cracked drier. To a certain point, if you don't know how pre-cracked it is, you have -

JUDGE REED: Well, we - pardon me - we are going to investigate that in some detail. So let's leave the question of not knowing for a moment, and proceed with this assumption that it does fail.

How can it do damage? That is the issue.

DR. HOPENFELD: Oh, okay.

I'll give you one example. Suppose the parts come in, fall down and interfere with the water that comes out of the spray nozzle, just don't let the water out. I don't know where those parts would fall. Suppose the whole lead hardened structure just falls on the core.

JUDGE REED: I'm not entirely familiar with boiling water reactors, so I'm needing some help here from this panel of experts.

What is - it seems unlikely to me that a loose part from the top of this reactor would be able to find its way down and block an inlet flow for cooling water.

DR. HOPENFELD: That was just one scenario.

JUDGE REED: I just would like to ask NRC once again whether you see any mechanism by which that would be either possible or likely?

MR. SCARBROUGH: No, sir, not for the injection flow. The steam drier in terms of the pieces, if there were pieces, they could come out and go down the steam lines. There are relief valves there. There are Ids there.

JUDGE REED: So failure of a valve is a possibility, but it's more likely that the loose parts would be carried down the steam lines and cause some failure down in that part of the system?

MR. SCARBROUGH: Yes, there was a situation at Quad Cities where a cover plate fell down directly on top of the motion separator. It was a large piece, and sat there. There is another piece at Quad Cities which they think did migrate down to the bottom of the reactor vessel head, where there was very low flow.

There is potential for components to move various places. From a point of view of a relief valve, unless the relief valves were open there is no driving head to push that piece up into the branch line for that relief valve. It is going to be sort of carried on down the stream, and there were some pieces found at Quad Cities in the turbine strainers. There were some strainers, found some pieces in the -- but that's - they do look at things like that. And actually the BWR VIP is - they have a BWR VIP 06 -

JUDGE REED: VIP?

MR. SCARBROUGH: Yes, BWR V-I-P.

JUDGE REED: V-I-P?

MR. SCARBROUGH: That group is looking at a document, they have a document called 06 where they look at various loose parts, and that is part of one of the documents they are upgrading now to look at where the potential - where could all these loose parts go if there were any. And that's what they are evaluating.

But in terms of a LOCA, I'm not aware of places where there might be a problem with injection flow.

JUDGE REED: Dr. Hopenfeld.

DR. HOPENFELD: In safety studies what you do is, you look at vulnerable places, even in channel, some valve that interferes with the shutdown procedure. And there may be others, some of them like I can't even think of, but there are many. You go through that, and you say, I don't know where this thing comes from. I know I have a potential source somewhere; I don't know how to get to it. Okay? You look at those, and you see what the consequences are. And then you run an insanity study and see whether that makes sense, whether you really have that kind of - insanity.

JUDGE KARLIN: Insanity? Okay.

DR. HOPENFELD: You see -

JUDGE KARLIN: Is that an acronym?

DR. HOPENFELD: No, I was just quoting these things that I hear. I have a very simple mind. So you see whether that makes sense.

Now what we hear here, it's talk talk talk, that we haven't done this, and we are looking at a situation that occurred four years ago and there were some parts carried into the turbine lines. But that is not a generalization. That's not a safety study that happens here. All that is it just sends you a signal because of better luck. But I haven't seen anybody conducting a safety study to see where those loose parts would come in. I've seen those studies done many years ago for BWRs and steam generators, the same thing. You don't sit there and figure out exactly how the thing is going to disintegrate, and when it's going to blow up. You just can't postulate that kind of thing. It's just too difficult. It depends on how weakened - you see what happens is, the reason this thing is brought up is because the structure is weakened, okay. You already have a weakened structure. And that's what you worry about. If it's weakened, then all these parts - by itself, the steam drier by itself is not a safety function. It's not a safety-related component, and it probably wasn't in the design for ASME code.

But now what we see, we have experience here, that you have four or five reactors have experience failure in this area, then that's the reason you have to see what the safety consequences are. And I haven't seen a study of that.

JUDGE REED: Okay, can I ask you to pause there.

And since you brought up this concept of several reactors having failures, I'd like to pursue that for a moment.

I'd like to direct my questions on this to Entergy. I'm not sure exactly which of you two gentlemen is the right person to answer these questions, but I will address them to both of you.

So what I'd like to do is understand a little bit better about the history of steam drier failures, in particular, I'd like to know more about the Quad Cities incidents of 2002 and 2003.

So I wonder if someone could briefly describe for me what happened in that reactor, in those years?

MR. HOFFMAN: Yes, sir. I might need to refer to a document.

JUDGE REED: Speak very loudly.

MR. LUKENS: Yes, sir, I will answer that question.

Quad Cities went through I believe it was a 117 percent power uprate. We started plant operation in early 2007 - March of 2002, excuse me. I believe it was March of 2002.

JUDGE REED: They started operations at the new -

MR. LUKENS: At the elevated power level.

JUDGE REED: And what was the increase?

MR. LUKENS: 117 percent I believe.

JUDGE REED: I thought it was 13 percent, but was it 17 percent?

MR. LUKENS: Yes, 1-1-7, yes, sir.

JUDGE REED: So very close to the 20 percent.

JUDGE WARDWELL: And what were the absolute power levels before and after? In megawatt or electric?

MR. HOFFMAN: I do not know the answer to that question. Nor do I plan to know it.

JUDGE WARDWELL: But a similar plant or a very different vintage BWR? How close are they? The two plants?

MR. HOFFMAN: Relatively similar, it's a BWR-3.

JUDGE REED: Both plants are BWR-3s?

MR. HOFFMAN: They're similar. They started operation. Through about three months of operation they noted some increase in motion carryover. At the time that was a new phenomenon, so they apparently didn't understand the meaning of that; operated a little bit longer; shut the plant down -

JUDGE WARDWELL: What do you mean by a little bit longer?

MR. HOFFMAN: About another month. Shut the plant down, and they found some failures, sections of the steam dryer.

JUDGE REED: And didn't they see initial anomalies during the course of that month in plant parameters?

MR. HOFFMAN: They found some additional - right - plant parameter anomalies.

JUDGE REED: So there is reason to believe that it wasn't a single incidence of failure, but a sequence of failures that occurred over a period of a month of operation?

MR. HOFFMAN: The plant is in regression of that failure. It started failing, and then progressed further.

JUDGE WARDWELL: Did any of the data indicate that? Or is that just a supposition on your part?

MR. HOFFMAN: That is a supposition. But obviously, that became the indicator that for unknown - perhaps unknown loadings occurring on steam dryers causing very rapid failures, essentially stress loadings that exceeded the endurance limit of the material and resulted in rapid failure.

JUDGE REED: Did you see any plots of the plant parameters over that month to see if there was a trend in any of them, either increasing or decreasing? Or just the jump -

MR. HOFFMAN: I have not seen any, no, sir.

JUDGE WARDWELL: Has anyone else seen those plots?

MR. SCARBROUGH: Nor for that event you are talking about. There was a later event -

JUDGE WARDWELL: We'll get to that later, I just wanted to - while you were still talking about it. Go ahead.

JUDGE REED: So can you explain why the plant was not shut down immediately?

MR. HOFFMAN: I can't answer. I didn't work for that company. I wasn't there.

JUDGE REED: Dr. Hopenfeld?

MR. HOFFMAN: I would like to make one comment. I think it is important, and it's informing to us. And it's on account of, meant made in regard to the new phenomenon. It's very important to realize what we are talking about.

Each time - and I watched the thing mostly -- each time there is an event the current that is being used, this is the new phenomena, you go out and look into what happened you find out it is not a new phenomena; it's just a phenomena that nobody has anticipated, because nobody has looked.

And what I'm bringing here is a phenomena that I think somebody should anticipate, that we already have a precursor to indicate that these things do - or could crack up. And you ought to look at it as a safety hazard.

And one reason I cannot answer all your questions, where these things go and exactly what happens with them and see that that study should have been done. It's GE's job to do that. But I haven't seen it done.

Accordingly, it's a new phenomena. It's getting away from that, from doing the analysis.

JUDGE REED: Could we continue with your description of the Quad Cities incidents?

MR. HOFFMAN: Yes, sir.

They shut the plant down, and they revealed, they found a missing part. They modified the plant. The root cause that they determined for that event was high-cycle fatigue.

JUDGE WARDWELL: Could you describe that mechanism that causes this fatigue, and how it differs from metal fatigue that, if you were here, we discussed quite much in detail the last day and a half, and what's the difference between the two, and the phenomena of it, and then the parameters or the conditions that tend to aggravate that particular phenomena associated with steam dryers.

MR. HOFFMAN: The difference would be - it is metal fatigue. The high-cycle fatigue is fatigue resulting generally in lower stresses over a large number of cycles, as compared to what you call low-cycle fatigue, which might be a high stress cycle over a low number of cycles.

If you recall the discussion about the SN curve, which is the cycles, stress versus the number of cycles, that you can have a very high stress for a low number of cycles; you could have a low stress for a high number of cycles. But you get to a point which you would call the endurance limit. It's the stress below which you could essentially operate an infinite number of cycles and not have fatigue failure.

And that is typically accepted to be on the order of 10^7th cycles. If you have a component that has experienced 10 million or more cycles, 10^7 cycles or more and hasn't failed, the second conclusion is that it's not subject to fatigue cycling. It will essentially operate untime-limited under those operating conditions.

JUDGE WARDWELL: The phrase, vibration fatigue, is also used, isn't it, for this situation?

MR. HOFFMAN: The vibration is what the loading is as compared to say a pressure loading or a tensile loading. It is what causes the stress, the fatigue of stress in cycles. And there can be a number of forces that cause that stress.

JUDGE WARDWELL: And then the primary source of those stresses are vibration. Are there any other situations that would cause those low-cycle stresses? The size vibration?

MR. HOFFMAN: In the case of the dryer, the vibrations, yes, pressure fluctuations causing vibrations, that is correct, sir.

JUDGE KARLIN: Mr. Hoffman, before we return to Dr. Reed's questioning, I'm trying to follow. You are talking about certain events that occurred at the Quad Cities facility plant.

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: I note that - I'm trying to follow this, the Exhibit D3-09, which is the BWR steam dryer SIL 644 describes a number of events. Which one are we - are we on one of those? For example Appendix A to that 644, SIL 644 describes an event on a certain date. Let's see what the date was. 2002, is that the event you were just testifying about?

MR. HOFFMAN: It was -

JUDGE KARLIN: Which one?

MR. HOFFMAN: Let me find it in this.

JUDGE KARLIN: Yes, the first one.

MR. HOFFMAN: Yes.

JUDGE KARLIN: On page one of the SIL they refer to a lower horizontal cover plate failure occurred in BWR-3 in 2002. Is that it? I mean I just want to know so I can follow what you are talking about?

MR. HOFFMAN: Yes, sir, that is it.

JUDGE KARLIN: Okay, then on page two of that SIL 644, they say, Appendix A provides more detailed description of this event. So the event you are testifying about is the event described in Appendix A of SIL 644?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: Great. I'll follow you there.

JUDGE REED: I'd like for Mr. Hoffman to continue describing these two events, because so far we have only touched on the first one.

MR. HOFFMAN: Okay.

The second event was an event at Quad City where they had a power - a power operated relief valve actuation. They repaired the valve, the plant returned to serve. After returning to service they found a change in the moisture carry-over, unexplained change in the moisture carry-over.

Plant operated for it looks like about three weeks. They saw that the moisture carry-over continued to increase. They reduced the power level to the pre-EPU level, and the moisture carry-over went down.

JUDGE KARLIN: May I ask, when you say the second event, is that referred to in SIL 644?

MS. HOFMANN: It would be Appendix Bravo, I'm speaking from Appendix B.

JUDGE KARLIN: Appendix B, okay, that is, and the event occurred in?

MR. HOFFMAN: April of 2003.

JUDGE KARLIN: Okay, are you getting your information about this event from SIL 644

mR. HOFFMAN: Yes, I am, sir.

JUDGE KARLIN: So you have no personal knowledge of any of this?

MR. HOFFMAN: I have no personal knowledge.

JUDGE KARLIN: Okay, so we could just as well read 644.

JUDGE REED: So in both of these events the plant operated for a period of weeks with, if I can use the phrase, off-normal parameters that should have led the plant operators to be concerned, but they continued to operate the plant with loose parts that had broken off the steam generator - steam dryer.

MR. HOFFMAN: The plant continued to operate with those abnormal indications, that's correct, sir.

JUDGE REED: I have several questions about this particular series of incidents.

First of all, was there an inspection program in place at the time, for the Quad Cities steam dryer?

MR. HOFFMAN: Not that I'm aware of, no, sir.

JUDGE REED: So they were not looking for cracks?

MR. HOFFMAN: They were - no, sir.

JUDGE REED: Is this the first time that the steam dryer actually cracked?

MR. HOFFMAN: Yes. As a result of power uprate, yes.

JUDGE REED: But were there other failures as a result of normal operation?

MR. HOFFMAN: I don't know that. I don't know that, sir, no.

JUDGE REED: What is the position of Entergy with regard to shutting down the plant, Vermont Yankee, if you detect any of these parameters like moisture carry-over that if you see a small change, what would your procedures require?

MR. HOFFMAN: We had a procedure that off-normal procedure ON-3178, that the operators of - in issue requires them if they see a change in any of the monitored parameters which are, as described in our testimony mismatches in steam flow, changes - unexplained changes in reactor film pressure; unexplained mismatches in reactor water levels; or increases in moisture carry-over. They immediately enter this off-normal operating procedure which requires an assessment of, do we understand why that moisture carry-over changed? Do we understand why the level changed?

There may be operating evolutions going on that you would expect those parameters to change, so you would conduct that evaluation. If it did not explain the reason for - the operators and the engineers cannot explain the reason for the changing of those parameters, and they conclude that it might be caused by dryer damage, there are immediate steps to be taken including power reductions and shutdown of the reactor.

JUDGE REED: So who would review these changes in parameters, and who would make a decision about continued operation?

MR. HOFFMAN: Parameter changes would be reviewed by the operators in the control room before the orientations. If they saw changes in those parameters, and they could not explain why they were changing, because of the evolutions they were going through, they would notify engineering. We would enter our engineering operations evaluation process, bring in the engineering folks to look at the data and start those evaluations.

JUDGE WARDWELL: And how long would that take in your estimation?

MR. HOFFMAN: They report immediately to engineering. Engineering would start work immediately.

JUDGE WARDWELL: This doesn't mean the next day when the engineers show up for work, it means immediately?

MR. HOFFMAN: Yes, sir. They would call people in office in order to do those evaluations.

JUDGE WARDWELL: So again, it is your belief that if there were a failure of the steam dryer at Vermont Yankee and it were detectible in the sense that you could see the results in some of the plant parameters, that the plant would be shut down immediately and would not continue like Quad Cities to operate for a period of months?

MR. HOFFMAN: That is correct; we would not. I could add, also, these - further bolstering of that is, once the issue was found at Quad Cities, the industry - and Vermont Yankee - started looking at, and we analyzed it. We don't have a situation where we have an increase in power level, didn't anticipate those vibrations, and didn't analyze them. They were, as Mr. Scarbrough said, thoroughly evaluated as part of the power uprating process, predicted to be below the endurance limit for the dryer.

They started a power extension test program that was conducted during the ascension to the higher power level, confirmed the analytical results. We have confidence that is not operating in a regime that is subject to high-cycle fatigue. And even above that we have this ongoing monitoring program to look for any changes in parameters. We are not relying on

- we have a double assurance essentially.

JUDGE REED: Are you familiar with the analysis that was done prior to the power uprate?

MR. HOFFMAN: I personally am not.

JUDGE REED: The analysis that was done prior. Mr. Lukens?

MR. LUKENS: I was not involved in that analysis.

JUDGE REED: Neither of you can speak to the analysis?

MR. LEWIS: No, sir.

JUDGE REED: But there was some sort of stress analysis done to determine that the fatigue stresses were below this endurance limit; is that - did I phrase that question correctly?

MR. HOFFMAN: Yes, that's correct. There were very extensive stress analysis.

JUDGE WARDWELL: What endurance limit are you comparing it to? Is it a cyclic limit? Is the limit determined from a cyclic test?

MR. HOFFMAN: Yes, it's the ASME code endurance limit.

JUDGE WARDWELL: Endurance limit for what? I mean there are all kinds of endurance limits.

MR. HOFFMAN: For the material, the

material of what's in this new material that the dryer is manufactured from.

JUDGE WARDWELL: Are you testifying that they have an endurance limit for cyclic stress loading?

MR. HOFFMAN: Yes, the SN curve would go down to a point where it is essentially asymptotic to a horizontal line.

JUDGE WARDWELL: This commitment to do these corrective actions that you were describing, these off-normal procedures, is that linked to your aging management plan program in any fashion?

MR. HOFFMAN: That is the - these monitorings, these parameters that are monitored are the ones described in the steam generator monitoring plan, yes, sir.

JUDGE WARDWELL: The aging management program that was submitted with your application makes no reference to any of these corrective actions that you just described.

So how is it linked to that?

MR. HOFFMAN: I don't understand the question, sir.

JUDGE WARDWELL: In your application there is no reference to any of these off-normal loadings, or any corrective action for that matter. A couple of hours ago we quoted what those were, and it was just basically a commitment to either continue the steam dryer management program as it now exists, or to go to VIP 139.

And that is only with your blessing in regards to some other recommendations. But it has no other details in regards to corrective actions like you have just described that would take place. How are those linked to those aging management programs to assure that they could and would be implemented?

MR. HOFFMAN: Those are the implementing procedures for executing the program. In other words the aging management program essentially will monitor those physical parameters, and will conduct periodic inspections. We have converted those statements into implementing plan procedures. And that's what the operators would do; that's what the engineers would use to carry out those requirements.

JUDGE WARDWELL: Well, part of a monitoring program associated with aging management would consist of corrective actions as part of the data collection, inspection, interpretation, evaluation and then implementation of what needs to be done in regards to actions associated with the information that is being collected, via visual inspection or monitoring of parameters.

You described nice corrective action. Where are those linked to in part of the aging management program?

And the reason I ask this is because I assume someone in your company could in fact change some of these off-normal procedures not knowing they are linked to any specific aging management plan required of a license renewal application, potentially even get it approved by the NRC staff if it wasn't flagged that these off-normal operations are linked to this aging management and circumvent what you just described as the program that is needed for this operation?

I'm trying to get some assurances that there is a linkage there so that that they can't be changed without recognizing that you are changing your aging management program.

Just to avoid too much delay here, if you want to get back to that, we will pick that up after a break or something, if we can remember to get back to it. I won't, so I hope somebody else will remember to get back to it.

Let me ask another question then. You

have many off-normal procedures, correct, for a variety of different measurements you are making as you normally operate the plant that has nothing to do with the steam dryer, correct?

MR. HOFFMAN: Yes, sir.

JUDGE WARDWELL: So in fact, and you may be monitoring, you will be monitoring some of the same parameters you monitor for the steam dryer in regards to other aspects that may be a cause for those off-normal types of values. Is that correct?

MR. HOFFMAN: Yes, sir.

JUDGE WARDWELL: So there is a potential that someone could accidentally - accidentally is the wrong word - inadvertently say, gee, we really ought to change this off-normal procedure if they weren't aware that it's in fact directed in part by the need to monitor this to determine whether the steam dryer is cracking? There is that potential, is there not?

Or is the title of this off-normal procedure an aging management program, corrective action for the steam dryer?

MR. HOFFMAN: The title is not, but the discussion in the procedure, which is an integral part of the procedure, says steam dryer cracking has been observed in the BWR industry. It's sort of spelling out what the purpose of this procedure is to respond to potential steam dryer cracking.

So the procedure does tie a linkage.

JUDGE WARDWELL: And what is that procedure? This is a written procedure, and it's in the control room and other places, in engineering et cetera, that dictates what needs to be done in response to various parameters exceeding the critical values?

MR. HOFFMAN: Yes, sir. This is called Off-Normal Procedure 3178, increased moisture carry-over.

JUDGE KARLIN: Is that an exhibit here? I mean do we have a reference we can see that?

MR. HOFFMAN: Yes, it's Exhibit 7, E-3-07 B1.

JUDGE KARLIN: Great.

JUDGE WARDWELL: I think that addresses the delay in question sufficiently.

MR. HOFFMAN: Okay.

JUDGE KARLIN: And if I may follow up a little bit, as I understand it there is a steam dryer management program consists of a dryer monitoring program and a dryer inspection program, right?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: Correct? And in your testimony on page 11 as we were discussing before, under what you had titled subparagraph B, dryer monitoring program, that's what we are talking, that's what you have been describing to us, the monitoring program as opposed to the inspection program; is that correct?

mR. HOFFMAN: Yes, sir, that's correct.

JUDGE KARLIN: Okay, and the dryer monitoring program, without going over question 24, describe the dryer monitoring program to be implemented. Question 25: How would this be - detect cracking? Question 26: What additional recommendations were contained in Rev. 2 to GE SIL 644, question 27, how is the monitoring and moisture carry-over to be performed?

Question 28: How and by whom is the significance of measurement and moisture to be assessed? Twenty-nine: How is the monitoring to be performed?

All these questions and answers deal with the steam dryer monitoring program, Rev. 3, which is part of the EPU and is going to be continued; is this correct?

MR. HOFFMAN: Yes, sir. Our plan is the

monitoring during plant operation for abnormal plant operation, coupled with the inspections during the fueling outage.

So the aging management is both of them.

JUDGE KARLIN: But if BWR VIP 139 is approved by the staff, and Entergy likes it, then all this is gone and something else is going to happen; is that correct? This is not describing BWR VIP 139. Does this describe BWR 139? Or does it describe -

MR. HOFFMAN: The parameters are generally the same, yes.

JUDGE KARLIN: They are generally the same.

MR. HOFFMAN: Correct.

JUDGE KARLIN: But this is not a description of BWR VIP 139, this is a description of SDMP - or steam dryer monitoring plan Rev. 3, right?

MR. HOFFMAN: That is correct, sir.

JUDGE KARLIN: Okay.

JUDGE REED: Okay, let's continue talking about the experience of the industry with regard to dryer failures.

We talked about Quad Cities. Could you share with us other incidents that have occurred throughout the BWR community?

MR. HOFFMAN: There was another event, I

wasn't personally involved in any of these events, I am reading from the report. There was a failure in March of 2004, fatigue crack, in the hood panel to end plate weld at BWR.

JUDGE KARLIN: And let me stop you. You are reading from SIL 644?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: Okay, fine.

MR. HOFFMAN: This particular crack occurred after approximately 16 years of operation, the last nine of which were at a lower power level increase, 5 percent stretch power. And it concluded that the weld was - this was not - given the length of time they concluded this was not high-cycle fatigue. It was a slower process.

JUDGE REED: Did they operate for a period of time with loose parts in the system?

MR. HOFFMAN: They did not.

JUDGE REED: Did they shut down immediately?

MR. HOFFMAN: My understanding of this one, they didn't see any abnormal plant parameters to indicate -

JUDGE REED: What led them to discover failure?

MR. HOFFMAN: My understanding is there was an inspection during a refueling outage. They were inspecting the dryer, and they found this crack.

JUDGE REED: Do you think it's possible in the case of Vermont Yankee that you could operate with loose parts in the system and not detect them?

MR. HOFFMAN: Mr. Lucas is here to answer the inspection part. We do ongoing dryer inspection.

JUDGE REED: Your inspections occur every refueling outage. What is the period of time between refueling outages?

MR. LUKENS: Eighteen months.

JUDGE REED: Eighteen months? So you could conceivably operate for a long period of time with a loose part if you are only dependent on inspections.

I am looking at how you detect dryer failures - how you monitor the plant to ensure that you are not operating with a failed dryer during routine operation.

We will come to inspections in a little bit.

MR. HOFFMAN: Our design analyses demonstrated, or concluded, that there would not be a high-cycle fatigue problem which would lead to the generation of loose parts. The startup test - or the power extension test program for the power uprate confirmed the validity of those analyses, and there is nothing that could cause those stresses to change above what they were when we increased power.

JUDGE REED: Well, that may be the case, and if I - if you were betting your money on that, you would say you didn't have to do any inspections or anything. You are confident that you are not going to have these failures. But you can't be certain. Is that correct?

MR. HOFFMAN: Not 100 percent certain.

JUDGE REED: You've done the analysis, you just said that you - I don't remember your exact words, but you were confident that nothing could fail because you have done some upgrades to the dryer, is that right?

MR. HOFFMAN: Yes.

JUDGE WARDWELL: In fact this failure mechanism is - didn't you testify that it is low-stress cyclic low cadences from vibration as opposed to any high peak stresses that causes this failure. Low stress measurements during the power uprate are significant in what fashion in regards to addressing this mode of failure?

Mr. HOFFMAN: High-cycle fatigue is high

number of cycles at a lower stress than a low-cycle fatigue, which is high stress low number of cycles. But there still are stress levels associated with it that could cause a failure, and there are stress levels below which you would not get a failure, because of stresses below the endurance limit.

JUDGE WARDWELL: And that's where you are in regards to measurements that were made during the power uprate?

MR. HOFFMAN: That's correct. The computational setting was below the endurance limit. The power extension test program would further what that remittance level would be, but we are confident that we are below, the stress limit is below cycle fatigue.

JUDGE REED: I'm a little puzzled. You keep bringing up this issue of computations. How significant is the analysis that you did prior to the power uprate in the actions that you are taking with regard to the steam dryer today? Is it a significant factor?

MR. HOFFMAN: It is not significant anymore, because we demonstrated at the time of power uprate that the stress levels were below the endurance limit and -

JUDGE REED: You demonstrated that. Now help me understand how you demonstrated it? By computation?

MR. HOFFMAN: Analyses -

JUDGE REED: Analysis?

MR. HOFFMAN: Analyses were performed to compute stresses. Confirmatory measurements were taken during the power ascension test program to validate those computations. And those are the stress levels that the dryer saw then and continues to see. So we no longer need to confirm those stresses, because there is nothing to cause the stress to change. They were caused by the operation at 120 percent power, and that's where we are.

So unless we change, unless we increase the power there would be nothing to cause those stresses to increase.

JUDGE REED: I believe Dr. Hopenfeld has some contentions with regard to this issue. I would like to give the floor to him for a minute.

JUDGE WARDWELL: Can we before we get to him, I'd like to get to a couple of more points on these stresses if we could.

JUDGE REED: Yes, sur.

JUDGE WARDWELL: If we could.

How are those stresses measured during the power uprate?

MR. HOFFMAN: They were measured by instrumentation placed on the main steam lines.

JUDGE WARDWELL: So strain gauges of some sort?

MR. HOFFMAN: Strain gauges and pressure gauges.

JUDGE WARDWELL: Why didn't you measure the dryer directly, stresses on the dryer directly rather than the steam line?

MR. HOFFMAN: I cannot answer that. It would require installation of strain gauges on the dryers. I don't know why that is so.

JUDGE WARDWELL: And where are those strain gauges now?

MR. HOFFMAN: It's just no longer in service.

JUDGE WARDWELL: Are they still in place?

MR. HOFFMAN: I don't believe so.

JUDGE WARDWELL: Is there a reason why you took them out, do you know?

MR. HOFFMAN: The requirement for monitoring ended after a certain period of time.

JUDGE WARDWELL: But it seems to me - have you ever heard - are both of you engineers?

MR. LUKENS: Yes, sir.

MR. HOFFMAN: Yes, sir.

JUDGE WARDWELL: In your general engineering experience with other industries and facets, have you ever heard of stress monitoring as kind of a common practice for various other types of engineered facilities in order to assure that it's meeting the design - the anticipation during the design?

MR. LUKENS: No, sir.

MR. HOFFMAN: I have not.

MR. LUKENS: Never heard of anyone doing it.

MR. HOFFMAN: I have not, no, sir.

JUDGE REED: Let's see, I was about to ask Dr. Hopenfeld if he had any comments regarding this issue.

DR. HOPENFELD: On a scale of zero to 100, their liability for their calculation is about 20. The reason - can you hear me?

JUDGE KARLIN: What's the basis for 20?

DR. HOPENFELD: My judgment, I told you.

JUDGE KARLIN: Oh, it's your judgment.

DR. HOPENFELD: I told you, from zero to

100, I would back him up. What they did, they had strain gauges somewhere in the steam lines, I don't know how many 16, whatever. From those strain gauges they used an acoustic model, and they calculated what the loads on the dryer are going to be at some critical location using a similar code to what we heard yesterday, some kind of FDN American analysis code reading the stresses, that document sourced. Now going from the steam line, and going to the dryer, is a big step. These equations are not that simple. You got a lot of different sources.

I imagine acoustic sources, different interferences, they interact with each other, this is not a trivial case. You just can't do that. Nevertheless they did that, they came up and GE ran a mockup at San Jose to benchmark, calibrate, in other words to see if they can rationalize or explain that those forces are really - are relevant to calculating the stress on the dryer.

Then they really never provided the detail of their analysis. They describe it to the ACRS, and they almost laughed about it, they didn't think it had any value, but never heard of -- if you look at NEC JH-54 and 5, the language concludes, what the ACRS conclusion there -

JUDGE REED: I'm sorry, could you give that reference again?

DR. HOPENFELD: Yes, 54-5.

JUDGE REED: Is the reference NEC JH-54 at page 5, sir?

DR. HOPENFELD: Yes. ACRS.

JUDGE REED: Okay, that's your report.

DR. HOPENFELD: Yes, it's my report. I don't see it - yes, okay, I said - I said in the middle of the page there, you will see you there the interpretation of the strain gauge data. If you ask the ACRS questions about whether they have done LOCA models -

JUDGE REED: Whoa, whoa, paragraph and line number, please.

DR. HOPENFELD: The second paragraph.

JUDGE REED: The second paragraph?

DR. HOPENFELD: On page five.

JUDGE KARLIN: So in that second paragraph it says, this is your report, this is what you wrote.

DR. HOPENFELD: Right.

JUDGE KARLIN: You are saying, and you quote: quote, ACRS questioned the validity of the analytical models, close quote.

Okay, that is your statement of what- you are quoting yourself as to what you are saying ACRS said.

DR. HOPENFELD: Right.

JUDGE KARLIN: Now, how do we know they really said that?

DR. HOPENFELD: I gave a reference.

JUDGE KARLIN: Is that an exhibit here?

DR. HOPENFELD: Is it? I don't remember. I believe it is.

JUDGE KARLIN: No, I don't think it is.

DR. HOPENFELD: Well, it's reference 10. Yes, it is.

MS. TYLER: I have to interject I think at this point if I may.

I don't think the original contention three was largely about the validity of the stress load modeling. The validity of these models that you are now discussing with Dr. Hopenfeld.

JUDGE KARLIN: Right, which is all thrown out if I might add when we grant the motion for summary disposition.

MS. TYLER: They represented that they were not using the models and relying on their prior analysis using the models. And on that basis the board, as we understood it, prohibited us from litigating this issue that you are now discussing.

JUDGE KARLIN: That's right. Are you objecting to your witness testifying on this subject?

MS. TYLER: I'm just noting I think that he has one paragraph of testimony about this issue in his testimony. And so we, based on instruction from the board, we really haven't submitted evidence -

JUDGE KARLIN: Well, let me try to stop you. Are you registering a motion or an objection of some kind, or is this just a speech? There is not motion here. We are allowing him to testify with regard to these computer models.

I would expect the NEC and the applicant to object to that, but we are allowing it.

JUDGE WARDWELL: And I'll modify a little bit also what Judge Karlin just said. I don't believe we are getting into the details of the model. We are talking about the stress levels that were measured during the uprate to indicate where we are at.

I'm sensitive of the fact that unless there is a demonstration that Entergy is relying on those models as part of their aging management plan, the discussion of those stress levels is still applying.

It is the motion for summary disposition related specifically to not challenging those use of those models in their aging management program, because Entergy has stipulated that they are not using those models.

If in fact it ever comes up here that they do need them, and they testify and end up saying, yes, we really do need that to reach a certain conclusion, then in fact that opens up the door again, at least in my opinion, and we'll have to discuss it as a board at that time.

That's all thrown out. In the meantime we are still wanting to have a feeling for how did these stress levels come about, and so far as my question is going to continue on in regards to whether or not it is practical to do it as part of an aging management plan, and a reasonable thing to do as an aging management plan.

But that's where it's going with it, and I don't believe we spent much time on the model. We are talking mostly about the stress levels.

I did hear the ACM wants from them. That's fine. We are not discussing how that applies to the aging management plan yet that I heard.

JUDGE KARLIN: All right, so let's just proceed.

DR. HOPENFELD: Well, going -

JUDGE KARLIN: Do we have a question on the table?

JUDGE REED: No, it was Entergy that brought up this issue of models earlier.

(Simultaneous voices)

JUDGE REED: Did they bring up the models?

JUDGE WARDWELL: Yes, they did.

JUDGE REED: I thought they were just talking about stress levels. I didn't hear anything about models from them.

JUDGE KARLIN: They didn't use the word models, but they used the word, model, but they used the word, analyses. So I think it's fair game for Dr. Holdenfeld to speak to this subject.

DR. HOPENFELD: I think it's very important to the model, when they talk about the validity of this analysis based on these models, it's not based - that's the key - it's not based - they didn't have - they didn't have strain gauges on the dryer to show you -

JUDGE WARDWELL: So you are testifying, just so -

(Simultaneous voices)

JUDGE WARDWELL: I'm stopping you now. To simplify and curtail your testimony you are testifying that in fact you object to the accuracy with which the stress levels that they assume to be or calculate to be on their steam dryer during their uprate may not be as accurate as they may think it is.

DR. HOPENFELD: Correct, and I'm giving you -

JUDGE WARDWELL: And that's all we need to know.

Is there anything else -

DR. HOPENFELD: I said 20 percent, and I was trying to explain why the liability of their calculation is no better than 20 percent.

JUDGE KARLIN: We're not here to litigate the validity of the models that were used for the uprate. We are not here to litigate the uprate that was already litigated.

Entergy has representatives, as Dr. Wardwell stated. And we based our ruling on the motion for summary disposition. On the representation that those models and those calculations in the uprate are not the basis for their aging management program in this matter. So we are pushing at the margins to talk about it at all. And unless and until Entergy - or we conclude that Entergy is using those models, then we are not here to litigate whether the models are good or bad.

DR. HOPENFELD: We're going by the models just because the validity of my statement is -

JUDGE KARLIN: Just let your counsel, Ms. Tyler.

MS. TYLER: I'd like to - if you do reach the conclusion that Entergy is relying on that analysis as the basis for its program, then we need to provide Dr. Hopenfeld the opportunity to actually submit testimony, prefiled testimony, about the model, and I don't think - I don't think you should be asking him to testify extemporaneously about something that he hasn't had the opportunity to -

JUDGE KARLIN: All right, I think that is fair enough. But that is not the issue that is before us here today. And if we devolve into an issue in this case we may have to deal with that at the time. But we don't see it as it, so I agree with that.

DR. HOPENFELD: Well, I'm sorry if I strayed off the farm.

JUDGE KARLIN: That's fine.

JUDGE WARDWELL: I think it's fair for you to put in perspective what you thought the accuracy of that stress measurement was.

DR. HOPENFELD: That's all I was trying to do.

JUDGE WARDWELL: Okay, we got that. Let's move on.

JUDGE REED: Okay, so let's go back to the issue, which is detection, monitoring programs, how you detect loose parts.

My understanding is that you monitor certain plant parameters, and that they go off normal to some degree, then you call in a plant engineer and look at the situation and decide whether or not you have loose parts, failure with the steam dryer.

Is that correct?

MR. LUKENS: Yes.

JUDGE REED: Do you have any loose parts monitoring system that listens for loose parts? Anything other that might alert you to the fact, the system?

MR. HOFFMAN: We don't have a loose parts monitoring system, no, sir. But I think I need to say that the monitoring - we believe the monitoring will detect dryer degradation long before we generate a loose part. Because part of the industry experience is loose part, if you are going to have a failure that's going to generate loose parts, it happens relatively quickly after you change operating efficiency, as demonstrated by Quad Cities where they increased their flow rates from high power in the course of three or four months they had failures.

We have right now over two years of operation, and we'll have an inspection in October. We haven't had any degradation as a result of our increase.

JUDGE REED: There are several points I would like to follow up on.

What is your statement that you believe your monitoring system can detect a potential failure of the dryer, not - before loose parts are generated. Did I hear that correctly?

MR. HOFFMAN: The monitoring program, checking for the parameter that we monitor, will be able to determine the development of dryer degradation. And we do not believe that if that degradation started to develop that it would progress rapidly such that we cannot - that we won't be able to detect and respond prior to the generation of a loose part.

JUDGE REED: So what do you mean by dryer degradation?

MR. HOFFMAN: Perhaps a crack developing, a crack developing that's allowing some bypass flow out of the dryer.

JUDGE REED: My mental picture of a crack is a pretty small thing. It might be quite long; it might be fairly deep; but it's microscopic in width.

Is that an erroneous idea of a crack?

MR. HOFFMAN: It could be. It could also - and those would not challenge the integrity of the dryer. But if you saw - if a crack were to progress and perhaps for a better word fish mouth, start to separate a little bit where flow bypass through it, that's when you would see the change in those plan parameters.

JUDGE REED: That's not really a crack. That's a hole, isn't it? I mean what - when you say a crack, to me - you're assuming this crack has opened up significantly, a matter of inches?

MR. HOFFMAN: Or it could be a fraction of an inch, enough to result in a bypass flow.

JUDGE REED: A fraction of an inch? And is it your position - what - let's talk about sizes. How big could this postulated crack be that you could detect? Length? It's presumably all the way through the metal.

MR. HOFFMAN: The study hasn't done - so

far we are looking at several inches of crack length -

JUDGE REED: Of length?

MR. HOFFMAN: And not even challenging the integrity of the dryer.

JUDGE REED: Yes. But how wide would the crack be? It'd be completely through whatever metal structure we are talking about, the crack would have to, in order to detect it, it would have to penetrate completely through the metal.

MR. HOFFMAN: It would penetrate through; that's right, sir.

JUDGE REED: So it's a full penetration crack, several inches in length, and how wide?

MR. HOFFMAN: It could open a small fraction of an inch, enough to allow the flow to start bypassing the dryer and leak out through that crack, that indication.

JUDGE REED: And it is your belief that a fraction of an inch by a few inches long, that you could detect a crack of that size and shut the plant down before a part - a piece of the dryer comes loose?

MR. HOFFMAN: What I'm saying is that if that started to develop, because we know we don't have high-cycle fatigue, it would not progress rapidly beyond that point where a failure would develop before we could shut the plant down.

It would be a situation that slowly developed; it would not be a rapidly propagating failure, because we don't have - by the demonstration of our successful operation so far, we don't have the driving forces to cause that high-cycle fatigue.

JUDGE REED: So if you did have high-cycle fatigue, and this crack developed, your point is that you would proceed rapidly to failure.

MR. HOFFMAN: We would have seen that very early. If the change in operating conditions due to power uprate is going to result in a high-cycle fatigue failure, we would have seen that already, because we have far exceeded the number in the cycle.

JUDGE REED: Okay, so your belief, you are ruling out high-cycle fatigue, as any consideration in your dryer maintenance program? You've ruled that out from consideration, is that what I'm hearing?

MR. HOFFMAN: The monitoring program simply monitors dryer performance during operation coupled with inspections looking for any cracking or degradation that might develop.

JUDGE REED: I thought I heard you say that you believe it's impossible to have high-cycle fatigue cracking on this dryer?

MR. HOFFMAN: We don't believe we will have high-cycle fatigue cracking in the dryer; that's correct, sir.

JUDGE REED: And so your programs for monitoring the dryer have to do with what kind of cracking?

MR. HOFFMAN: The cracking we've seen so far has been typically IGSCC cracking that has not grown very much. It's been either stable, or - Mr. Lukens could discuss the inspection results better than I could - but the cracks that we have seen from one cycle to the next essentially have not changed length, and where new cracks have been developed during an operating cycle, they have been very small. So we are not seeing the development of large cracks during operating cycle.

JUDGE WARDWELL: Can I rephrase it that may help you? To make sure I understand.

Your monitoring program is looking at operational parameters would indicate some type of breach in the steam dryer, i.e. an opening, a bypass, something of that nature, regardless of how it took place. So it's not focused toward any mechanism that causes that bypass or opening to occur, but is there to observe the opening or the bypass, the effects of the opening or the bypass.

MR. HOFFMAN: That's correct, sir; results-driven and not cause-driven.

JUDGE WARDWELL: So whether it's high cycle or low cycle or just so accidentally during a shut down punched a hole in it because - whatever reason, it wouldn't matter, because your monitoring parameters are intended to detect just a breach or a bypass?

MR. HOFFMAN: Right.

JUDGE WARDWELL: How would, how big - and I think this is part of what Judge Reed was trying to get to, and I want to get back to it, what is your normal moisture carry-over reading during routine operations, what is the value of that?

MR. HOFFMAN: If I may sir?

JUDGE WARDWELL: Yes.

MR. HOFFMAN: This morning it was 0.137 percent.

JUDGE WARDWELL: 0.137 percent? How big an opening would you need to increase that? It seems to me it would be fairly big, considering you have so much mass of dry steam coming out, and you've got - if you had just a small crack sitting at one location fo one vein, and yes, that's bypassing, but there is an awful lot of other stuff that is going through that dryer that ain't getting through that little opening that it would be hard to change that parameter much.

What indications do you have that it is sensitive enough parameter to detect the smaller cracks so that you can anticipate taking some action before the steam dryer actually creates loose parts? Either of you.

MR. HOFFMAN: The way I would answer that is that if we had a flaw developing, all our inspections show that the flaws developed very slowly. So if it got to a point where we saw a change in plant performance due to a potential degradation of the steam dryer, and we concluded that the change in say moisture carry-over level was caused by a potential degradation of the dryer, it would not progress to the point of failure in the very short time it would take to shut the plant down.

JUDGE WARDWELL: So another way to interpret what you just said to me, and correct me if I'm wrong in using this interpretation, that the moisture carry-over may not show anything until you have quite a bit larger crack or a larger number of cracks at present, but the smaller cracks that wouldn't be sufficient size to impact moisture carry-over would be detected during inspections based on what you ascertain or believe to be the low propagation of those cracks.

MR. HOFFMAN: Yes, sir.

JUDGE WARDWELL: What is your basis for assuming that those cracks propagate slowly?

MR. HOFFMAN: Demonstration by having repeated inspections of the same indications and not seeing any - in some cases zero change in length.

JUDGE WARDWELL: I've had a crack in the windshield of my car that started off as a little rock ding, and nothing happened until about two months into it, and then it started going, and then it started going fast. So it went many months doing nothing, and then all of a sudden it started propagating like crazy.

Couldn't that same behavior occur?

MR. HOFFMAN: No, sir, the material in the windshield is a non-ductile material; it's a brittle material; it can be subject as you said, as I have had the same unfortunate experiences, very quickly fast-running flaws. Austenitic stainless steel is a very ductile material, and you just do not get brittle fracture fast-running flaws in stainless steel. It's an extremely ductile material; very very ductile material.

JUDGE WARDWELL: Thank you.

JUDGE REED: I still - oh, I'm sorry, please, you've been trying to ask a question.

JUDGE KARLIN: I may be interrupting this, but if I could refer you to testimony, it helps me understand where we are. Page 11 again of your dryer management monitoring program. I am positing there is an inspection program every time there is a refueling outage, and there is monitoring that goes on continuously.

And here you are describing - and you say, and I quote, the status of the steam dryer is assessed continuously by the plant operators, and then you go on to say, the following events could be - through the monitoring of certain plant parameters. And the following events could be indicative of significant dryer damage, quote: A, sudden drop in main steam line flow of greater than 5 percent; B, sudden drop in steam dome pressure greater than two psig, pounds per square - gauge.

And C, sudden drop in steam dome pressure greater than ps - I guess, did I miss one in there?

MR. HOFFMAN: Yes, the bravo three.

JUDGE KARLIN: Yes, bravo, B, greater than three-inch difference in reactor vessel water instrument - water level instruments. So that is your continuous monitoring, right? Those are the three parameters that you are continuously monitoring?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: And that is the monitoring program, or at least part of it, that you are talking about, right?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: And then the next sentence, quote: in addition, periodic measurements of moisture carry-over are performed, and changes in moisture carry-over are evaluated per - and it quotes SIL 644, closed quote, right?

MR. HOFFMAN: Yes.

JUDGE KARLIN: I'm with you. So first there are three parameters that are continuously monitored, right?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: And another parameter, moisture carry-over, is periodically monitored, right?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: And periodically, if I think I remember somewhere, it's twice a day? How often is the moisture carry-over periodic monitoring?

MR. HOFFMAN: Now it's weekly.

JUDGE KARLIN: Once a week?

MR. HOFFMAN: Once a week.

JUDGE KARLIN: Okay, and so those are - and that is the plan going forward, aging management program, to do it once a week?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: Okay, once a week, and that is the monitoring program. And I guess - let me ask this on the continuous monitoring of those A, B and C parameters, are those parameters just automatically normally measured, monitored in a reactor? Or are they being especially monitored because of the aging management program?

MR. HOFFMAN: The parameters themselves are monitored normally. What we are looking for in the aging management program is anomalies.

JUDGE KARLIN: Okay, so that stuff is monitored anyway. And how about the moisture carry-over, is that monitored anyway, or is it only monitored because of this aging management program?

MR. HOFFMAN: I don't know the answer to that, but it was done previously. I know it's done now weekly.

MR. LUKENS: We perform moisture carry-over measurements prior to uprate. However the frequency was increased shortly before we went to uprate conditions.

JUDGE KARLIN: Okay. So the only thing different you are doing is, your moisture carry-over is more frequently being monitored, and someone is paying attention to these values, and there are some action levels if they exceed the three or the five or whatever; correct?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: Now on page 16 - I'm sorry, I believe it is 14 of your testimony, in question #30, here you talk about that.

Question: What happens if abnormal values are measured?

And then you describe certain - if any of the action levels are reached, procedure requires a moisture carry-over. So if any of these action levels that meets with a continuum, what do you do? First thing you do, are you saying you got to go do a moisture carry-over measurement?

MR. HOFFMAN: Yes.

JUDGE KARLIN: So that's the first thing. And then what happens after that? The personnel involved - quote, the personnel involved in determining the significance of the moisture carry-over and other measured parameters are - apparently you have someone who makes a judgment call at that point?

MR. HOFFMAN: If you saw a change in the monitored parameters, the first step would be, get a moisture carry-over measurement. If that had changed above normal, which would then be indicative of potential dryer failure, there are action levels in that procedure, ON-3178, that I spoke about, which would involve reporting to plant management; getting the engineering personnel involved; and starting an evaluation of what was going on to determine if the monitoring parameters, which can change for other reasons, were being caused to change by a potential dryer failure.

JUDGE KARLIN: Okay, I'm with you. And you've got the three continuously monitored parameters, which are normally monitored anyway, then you have moisture carry-over that is periodically - and we have been talking about cracks and the size of cracks and two inches and what they are. But what you are looking at is these four parameters as it were, three parameters plus moisture carry-over, and then a judgment call is made if there is some change in those above these thresholds, somebody has to make a judgment call whether that involves a problem with the steam dryer.

MR. HOFFMAN: A technical evaluation would be multiple people getting involved, and assessing the data and making a technical determination, is this indicative of a dryer failure?

JUDGE KARLIN: Now are there other things going on in a nuclear power plant that could also cause these parameters to change, these values to change, say, a sudden drop in main steam line flow over 5 percent?

MR. HOFFMAN: It could be, and that's why the party evaluation is something else potentially causing that problem or that change.

JUDGE KARLIN: And a greater than three-inch difference in reactor water - vessel water level, I mean that could be caused by a lot of things, couldn't it?

MR. HOFFMAN: It might be, yes.

JUDGE KARLIN: So the parameters being measured, the changes in them could be caused by a lot of different things that are going on in a nuclear power plant, correct?

MR. HOFFMAN: There could be other things than a dryer failure causing changes in those parameters, and that's what the evaluation -

JUDGE KARLIN: Could be a lot of other things? Is that correct?

MR. HOFFMAN: I wouldn't quantify a lot or a little, but it could be.

JUDGE KARLIN: All right. And so someone has to make a judgment call at that point. Parameters are exceeded, first thing you do is do a moisture carry-over analysis. The moisture carry-over analysis, and the parameters have been taken to some group of people who make a decision as to whether this indicates a problem with the steam dryer or a problem somewhere else, or whatever, and it's a judgment call, okay, but it's not like somebody has got a periscope and is looking into the steam dryer and sees a crack that is two inches long.

MR. HOFFMAN: Not at that point, no, sir.

JUDGE KARLIN: Okay. And I think a lot of the questions here are the same question I have is, what are the resolution power of these parameters, the measurements you are taking? To what degree is judgment involved in - it's not like you have a microscope. How much can you see? Is it a two-inch crack? A one-inch crack? A ten-foot crack? What are you seeing?

You are seeing - what causes - what in the steam dryer other than a crack might cause this? Could the thing bend and cause a problem, or is that - change in one of these parameters?

MR. HOFFMAN: I think it's the other way around. Changes in power level, changes in say feedwater temperature could affect one or more of those parameters, perhaps moisture carry-over. So it could be other plant parameter changes that are causing - or plant operating changes that are causing changes in those parameters, and that's what that technical evaluation would sort out.

JUDGE KARLIN: Okay.

JUDGE WARDWELL: Let me add another question on - along these lines, but worded a little bit different way. In order to see - if it was - if the steam dryer was cracked, due to vibration fatigue, in a number of places, wouldn't it take quite a large crack to see any steam flow drop of 5 percent, greater than three-inch difference in reactor vessel water level measurement, and a drop of two psi in the dome pressure core?

MR. HOFFMAN: It potentially would. Yes, sir, it potentially would. And I think that's where our program is - because we don't have high-cycle fatigue - the whole problem in the industry arose from some initial plans that had some high-cycle fatigue failures. And they saw changes in parameters.

So what the industry has done is said, these folks had problems. They saw changes in these parameters. Other people should look for those similar changes in parameters as a precursor to potential problems.

JUDGE REED: Once again, you've said you don't have high-cycle fatigue. And I just want to make sure I understand the basis on which you make that claim. And I believe there are two things.

One is your analysis prior to the power uprate, and the second thing is simply the fact that you have uprated for, what, approximately three years now, at the higher power and seen no failure? Is that -

MR. HOFFMAN: It's really the second one.

JUDGE REED: It's really the second one?

MR. HOFFMAN: We never do this, and you could conceivably - we could have built a component and never analyzed it and simply operate it, and operate it beyond a certain level without a failure you would conclude without any knowledge of what the stresses were that it was not subject to high-cycle fatigue.

JUDGE REED: So since it hasn't broken, it's not going to break?

MR. HOFFMAN: That is essentially - high-cycle fatigue -

JUDGE KARLIN: Yes, I agree, but let me ask: Is your program trying to predict whether it's going to break or detect whether it's broken?

MR. HOFFMAN: The monitoring program is a - the in-service monitoring would be after the fact.

JUDGE KARLIN: Right, and so on page 15 of your testimony, in answer to question #33, you say, the question is, will the measurements of moisture, et cetera, et cetera, for reactor, enable Entergy to determine whether a dryer crack is about to form?

And you say, no. The purpose of the measurements is to provide early warning that a crack may have developed. You are not trying to predict a crack; just trying to detect one that's occurred.

MR. HOFFMAN: Detect one that's occurred, and that has resulted in a change in dryer -

JUDGE KARLIN: Because a steam dryer is not a safety component of the reactor, correct?

MR. HOFFMAN: That's correct.

JUDGE KARLIN: And the problem is not whether a steam dryer fails, because that is not a safety-related component of the reactor, but whether a steam dryer failure, that is, a piece from the steam dryer, could cause a failure somewhere else on the system; right?

MR. HOFFMAN: Yes, sir.

JUDGE WARDWELL: And a crack, a single crack, wouldn't cause - it may be a failure of the steam dryer, it doesn't have an impact on anything else until it's large enough so it creates a loose part?

MR. HOFFMAN: Yes, sir.

JUDGE WARDWELL: And you are also relying on the slow propagation of cracks that do occur as part of your plan in order to catch those during the visual inspections that occur at selected refueling outages?

MR. HOFFMAN: That's correct. If we do it on high-cycle fatigue, it'd be a slow development of any flaws.

JUDGE WARDWELL: But it wouldn't if it was a high cycle?

MR. HOFFMAN: Yes.

JUDGE REED: Dr. Hopenfeld, do you agree

with Entergy's position that we can rule out fatigue failure of the dryer on the basis that since they've operated for an extended period of time at the 20 percent increased power, that we would have seen this failure if it was going to occur?

DR. HOPENFELD: No, because the only way you can show that would be by calculations, just by the calculations we discussed yesterday. You would have to show that you are not - where are you as far as routine endurance. And the only way you can do that if you knew what the loads on the dryers were.

This is just - this is an opinion, a judgment of somebody, that 18 months is sufficient to conclude that nothing will happen in the future.

If this was the correct situation, if this was a correct statement, then all the reactors in the country would have been - we would have never seen any failure from fatigue, from flow-induced vibration, from any system after they operated for 18 months.

And I realize that I am a little bit vague here, because each system is different. They may have something that causes the vibration to change. But the Vermont Yankee is not an operating room in a hospital. Things change there, too.

JUDGE KARLIN: Can I ask a question, Dr.

Hopenfeld? I'd like to put a little different facet on the question Dr. Reed was asking.

As I understand it, Entergy's position is a steam dryer is not a safety-related component. Over the next 20 years there may - they are not saying that there will never be a chunk or a piece of metal come off the steam dryer. Let's assume there is. I think they are not guaranteeing that it will never happen. What I think they are saying is, look, we are going to monitor it. We are going to monitor these parameters. We are going to inspect it every 18 months visually. And if a chunk falls off, we will detect it pretty fast, and we will be able to manage it in a way that no safety problem will arise.

Now there is a debate whether a safety program will arrive, but they are not trying to say there will never be a chunk come off. They are just saying, if it happens, we'll catch it and we'll deal with it. Isn't that right?

DR. HOPENFELD: That's exactly what they are saying. There are two things that are important. There's the situation where you have a crack and it hasn't gone through the wall. A bunch of cracks; they haven't gone through the wall. They may be let's say five mils from breaching the wall.

In the case of sudden large change in forces on the dryer because of the DBA. And mind you, DBA, it's not a hypothetical place. This is not a severe accident. This is something that, it's part of the what the COB, they are responsible for that. They have to show you that what this event in the dryer, this formation of the crack, would extend the DBA. It's part of DVC 40 and 42, which requires you to provide protection to the public against events like that. And I haven't seen anything -

JUDGE REED: Can we stop there, and ask the NRC staff to verify your statement? Is it your belief that the claim that Dr. Hopenfeld just made is correct?

MR. SCARBROUGH: They are required to evaluate the dryer for all possible floats, and local loads and such as that.

JUDGE REED: Including design-basis accidents.

MR. SCARBROUGH: Right, yes, sir. And they did that as far as power uprate, and they evaluated it. And the loads for - well, the allowable loads are different for those types of situation. You are allowed to have some structural deformation of the dryer, because if you have a LOCA you are shutting the plant down. It's not a long term fatigue oriented level that you are looking for in normal operations. So they did look. They did an evaluation. The technical staff looked at that, and determined that the allowable loads were adequate for that dryer.

JUDGE REED: So basically you are saying if you have a LOCA, the dryers are the least of your worries; it's not something you are concerned about?

MR. SCARBROUGH: Yes, sir.

JUDGE KARLIN: But I thought Dr. Hopenfeld's point is, but if you have a LOCA and that triggers a steam dryer, chunks of metal coming off the steam dryer, I won't call it a total failure, LOCA occurs, steam dryer has a failure, chunks come off. Does that exacerbate the problem, the LOCA then? And doesn't that have to be - isn't that something that would have to be considered and dealt with?

MR. SCARBROUGH: If those chunks came out they would be heading out the same hole that all the steam would be heading out for the LOCA anyway. I mean you are losing - that is the direct path out of the -

JUDGE KARLIN: Has that been considered by the applicant and the staff? I mean deciding that the steam dryer is okay the way it is?

MR. SCARBROUGH: I don't know if they have evaluated that specifically in terms of - their evaluation was where the stresses are so high that you would exceed the allowable limits of the dryer. In terms of looking at it beyond that, that is something that the BWR VIP has looked at.

JUDGE KARLIN: You are focusing on the EPU, right?

MR. SCARBROUGH: Yes, sir.

JUDGE KARLIN: Okay, so Mr. Hsu, were you the one who looked at this for renewal?

MR. HSU: Yes, we looked for the renewal. But from the renewal point of view. We are now looking at an engineering point of view, and we are looking at monitoring, the monitoring and detection, that point of view; not look from the engineering point of view.

JUDGE KARLIN: So if I may, you did not look at, well, if there is a LOCA, and the LOCA causes the steam dryer to break pieces off, and those pieces could exacerbate the LOCA and cause different problems, you did not look at that?

MR. HSU: We did not look at that. We only look at that because of this detection and worry that it's the best. Normally it's not going to happen.

JUDGE KARLIN: So you are saying - no, I'm not sure, I don't think there is a guarantee it isn't going to happen. I thought it was, they are not evaluating prediction. They are just going to detect it if it does happen, right? Is this right, Mr. Hoffman? I mean the monitoring program is not to predict what's going to happen but to detect if a chunk has come off?

MR. HOFFMAN: The monitoring program will not - cannot predict that a crack may develop to start. It is there to determine if a degradation has occurred that challenges dryer integrity, in which case we would shut the plant down and take corrective action, so that way.

JUDGE KARLIN: Thank you.

Now, Mr. Hsu, are you saying you8r acceptance of this was based on some understanding that the monitoring program would prevent any of these things from happening?

MR. HSU: The monitoring program would detect -

JUDGE KARLIN: Detect.

MR. HSU: - and give you the early warning before these things happen, because a crack -

JUDGE KARLIN: Well, wait a second. Does

the monitoring program detect before a chunk comes off? Or does it detect that in fact a chunk has come off?

MR. HSU: Before.

JUDGE KARLIN: Now I'm asking Mr. Hoffman, or that a crack has developed or a hole -

MR. HOFFMAN: You are not - it could be both, sir, in the sense that you have a spectrum of events. It could be a small piece has come out that results in a moisture carry-over of a certain failure. Or it could be a contiguous flaw that has opened up a little bit and allowed some bypass flow. So it will not differentiate.

JUDGE KARLIN: Okay, let me ask - that is - that's a question. You talked about, I asked you about the changes in the main steam line flow and the difference in the water level. What if it's slow? Over what timeframe does this change occur, that it triggers this action? I mean if the sudden - you have a sudden drop in the main steam line flow of greater than 5 percent. Define sudden.

MR. HOFFMAN: The operators are continuously scanning the control panel, so we are talking minutes. They may have looked at the instrument, then a couple of minutes later they check it -

JUDGE KARLIN: So if it - and -- because I'm concerned about the difference between creeping change of little pieces start falling off, and because they are small they are not detected until some big chunk finally - the dam breaks or something.

Is this going to distinguish - if there was gradual breaking off of pieces, would there be a sudden drop in the main steam line flow, would that pick it up? Or would you miss a gradual increase resulting from problems with the steam dryer?

MR. HOFFMAN: Once again, I don't think - we don't conclude that there is going to be a gradual breaking off of pieces, because those would be driven by high-cycle fatigue failures, which we don't have. We don't have a high-cycle fatigue situation.

JUDGE KARLIN: Yes, but this program is not telling us that it is never going to happen. I thought you were saying, we're not telling you it ain't going to happen. We're just saying if it happens we are going to detect it.

MR. HOFFMAN: If it happens the program would detect it, but implicit in that is that we don't believe it's going to happen.

So I guess it's hard to answer the

question in that the parameters -

JUDGE KARLIN: Well, if we didn't think anything was going to happen then we wouldn't have to monitor any of these things. If that was all we needed, the EPU is granted, everything is fine, no monitoring program, because it ain't going to happen.

But you are monitoring it, and you are managing it, and this is part of your plan. So I'm positing that you are doing it for a reason, because you believe, you want to be careful, and if it happens you will detect it.

But I guess what you are saying is, your detection program is focused not on the high - what was the word?

MR. HOFFMAN: High cycle.

JUDGE KARLIN: Not on the high-cycle fatigue but on the low-cycle fatigue type of problem.

MR. HOFFMAN: Which would happen very slowly.

JUDGE KARLIN: I'm sorry, somewhat of a digression, but thank you. ;

DR. HOPENFELD: I would like to comment on that, because I really -

JUDGE REED: I want to ask you a question, Dr. Hopenfeld.

DR. HOPENFELD: I didn't finish answering the first one.

JUDGE KARLIN: Are you satisfied?

JUDGE REED: Well, I'm going to ask you a follow up.

DR. HOPENFELD: I had two parts to my answer to the question. And I started with the first one. I said the crack will go through the wall. Monitoring is irrelevant. Suddenly, we're talking about monitoring. That's not what monitoring. In effect, monitoring --

JUDGE WARDWELL: Can I stop you for a minute?

DR. HOPENFELD: Yes.

JUDGE WARDWELL: What question are you answering?

DR. HOPENFELD: I was answering a question about commenting - I was asked I should comment about the monitoring program, and their perception about the stresses. That's what I was answering.

JUDGE REED: I want to ask you a very specific question. Earlier you made a point that I would like to follow up on, which is you believe that if we could rule out - let's see if I can state this carefully - Entergy has asserted that they can eliminate high-cycle fatigue as a cause for cracking.

You made a statement that you disagreed with that.

DR. HOPENFELD: Correct.

JUDGE REED: And you gave a reason for that?

DR. HOPENFELD: Correct.

JUDGE REED: And I'm going to try to paraphrase your reason. I think it was that if that were the case, then we would never have seen a high-cycle fatigue cracking of a dryer beyond a few months of operation being your point. Did you make that statement?

DR. HOPENFELD: (No audible response.)

JUDGE REED: Pardon me?

DR. HOPENFELD: I said 18 months.

JUDGE REED: Eighteen months. So you did make that statement?

DR. HOPENFELD: Yes, I said in all the plants.

JUDGE REED: So can you cite for us an example of a dryer that cracked beyond 18 months as a result of high-cycle fatigue?

DR. HOPENFELD: Sir, I wasn't talking specifically about dryers. I was more general. I said you wouldn't see flow-induced vibration wouldn't be a problem anywhere. Because if he's constant there, what he was alluding, not just the dryers, he said, we don't see - what he was saying, as I understood him, he said, we don't see something happen up to 18 months it's never going to happen. That really is not specific to the dryer; it's specific to anything.

JUDGE WARDWELL: So can you cite any examples where there have been failures at a given power level several years after the initiation fo that power level due to vibration -

DR. HOPENFELD: There have been many failures due to vibration in various parts of the system. I know there have been failures in BWR steam generators. I am talking generally.

JUDGE WARDWELL: It does have something to do with it, because Vermont Yankee is a BWR.

DR. HOPENFELD: No, I understand, but what I'm talking about -

JUDGE WARDWELL: I'm asking you do you know, can you cite any examples of failures of components due to vibration fatigue, high-cycle loadings, several years after a given power level has been initiated?

DR. HOPENFELD: In BWRs?

JUDGE WARDWELL: In BWRs.

DR. HOPENFELD: I think there was some, but I don't remember. I think there was some at least tell me where the feedwater nozzle were, but I don't remember the BWR. In this case I was just talking in general.

JUDGE REED: Let's ask the other witnesses the same question. Are you aware of any circumstances in which a component has failed due to fatigue beyond 18 months following a change in plant conditions?

MR. SCARBROUGH: Now for the Quad Cities plants, we talked about those. They happened very quickly.

JUDGE REED: I'm sorry, what?

MR. SCARBROUGH: For Quad Cities Unit #1 and #2, Quad Cities #2, first failure was like 90 days after it first went up to the EPU, changed power levels; and then it failed again, and then about a year later. So about a year operations for Quad Cities #1 in November of 2003, it failed.

And the sister plants for Quad Cities -

JUDGE REED: So there is an example of one year.

MR. SCARBROUGH: One year, yes, sir.

JUDGE REED: One year. But we haven't gotten as far as 18 months.

MR. SCARBROUGH: In Dresden it was along that line. I wouldn't say a year or 18 months, but it was a longer time period. They had actually been trying to install modifications to the dryer to try to strengthen it, and what they found was, when they went in and did inspections, because the Quad Cities had failed, they went back and looked at those modifications they had performed for Dresden, and they found some cracks where they had put those modifications in.

So what they found was the modifications were not helping too much. So they ended up replacing the dryers at Dresden as well just to deal with the issue and get it over with.

So that was - if you are looking for something that was a little bit longer, Dresden was a little bit longer timeframe than Quad Cities, but the loading was different, and they ended up putting the modifications in to try to correct it and actually found the modifications weren't -

JUDGE REED: In the Dresden case was it attributed to this high-cycle fatigue?

MR. SCARBROUGH: Yes, sir, it was the same phenomenon that happened at Quad Cities where there was acoustic resonance that was upstream from the relief valves hitting the resonance and hitting the dryer. And Quad Cities and Dresden are almost identical plants in how they are designed, and so they ended up - it's natural that they would have similar issues going on. Dresden has a slight different variations of how the branch lines were connected. It ended up their loads were occurring at a lower power level, the resonances were occurring at a lower power level, and so the levels were not as high.

But the net result is, they did fail as well. So those are the two plants, the two separate plants, Quad Cities #1 and #2, Dresden #2 and #3, that had this phenomenon. But those are the only ones that I know of where there was this longer timeframe involved.

There were places when plants first started up years ago like Susquehanna where there were small cracks that they found in the dryer as they started the plants up.

JUDGE WARDWELL: Can you explain the mechanism again of how Dresden and Quad Cities failed? You said it, and you said it fast.

MR. SCARBROUGH: The steam lines - the

flows in fact put forth for this case, there are various mechanisms that can occur and cause vibrations. But the mechanisms that were the severe mechanisms for Dresden and Quad Cities, the ones that we're most concerned about, are where you have steam flow down the line after the branch opening for a relief valve, for a branch line, or something. When it passes over that there will be vortices shed across that branch opening. And when that vortices matches the standing wave for - you may get an acoustic resonance, get a reinforcement. And that will travel back upstream through, and then strike the face of the dryer. The face of the dryer is facing that main steam line opening, and travels up and strikes that. And that was what was obvious at Quad Cities when they instrumented the steam lines. You could see that at Dresden, as well when they implemented the replacement dryers at Quad Cities, one of them was instrumented to see actually what was happening. And that confirmed what we were seeing downstream.

JUDGE REED: Was there a calculation done to confirm that the vibrational frequency of the dryer component that broke was essentially the same as - was it in resonance with this acoustic -

MR. SCARBROUGH: My understanding was, the forces coming back were just so high they exceeded the fatigue limit. So when they did the calculations they saw, that yes, it should fail, and it did fail, because those forces striking the dryer were above the fatigue limit so it was a very high cycle. It happened very quickly.

JUDGE REED: so it didn't really need to be in resonance you are saying.

MR. SCARBROUGH: No, sir.

JUDGE WARDWELL: In fact it's almost like a static, where your high enough cycles that you are -- it's almost like a static load on, or a continuing load on it.

MR. SCARBROUGH: Yes, it was very periodic.

JUDGE REED: So Dr. Hopenfeld has postulated a possible resonance effect here. Is it -- what is your opinion about that with regard to this particular plant, Vermont Yankee?

MR. SCARBROUGH: The steam dryers, as the flow comes out and goes over the steam dryers out the relief lines, or the main steam lines, there are vortices shed across the edges of the dryer as it rolls down. And there is a potential there for resonance to occur with that structure.

What we found is, those types of issues

are not of concern. The reason concern was this acoustic resonance traveling back upstream. That's where the real heavy loads were.

JUDGE KARLIN: The what kind of resonance?

MR. SCARBROUGH: Acoustic resonance.

JUDGE KARLIN: Acoustic? Okay.

MR. SCARBROUGH: And so there is that potential, and that was looked at very closely back when the first failures at Quad Cities occurred. Because the - one of the cover plates that failed was a quarter-inch thick; very thin. It failed off Quad Cities Unit #2. And so there was a lot of discussion of, could it be these vortices coming off, which shed very low frequencies, below 100 Hertz, where these acoustic resonance coming upstream are much higher frequencies.

And so there was a lot of discussion of where that was occurring. So that is possible, but the concerns that we have now for this acoustic resonance are the higher frequencies that come from these lines downstream. But that was something that was looked at and was evaluated.

At Vermont Yankee they did two types of analyses to evaluate what would happen.

JUDGE KARLIN: With regard to the uprate?

MR. SCARBROUGH: Yes, sir.

JUDGE KARLIN: All right.

MR. SCARBROUGH: They did a computation fluid dynamics -

(Simultaneous voices)

JUDGE REED: But it did take place?

JUDGE KARLIN: It took place in fact. If you start - go ahead.

JUDGE REED: I thought we were going to listen to why it is important.

MR. SCARBROUGH: But they did look at that. That was an area they looked at. But in terms of the concern, the dryers have operated many many years in the power plants without any significant failures that we saw in Quad Cities due to cracking. And the cause of that severe problem was this sort of acoustic resonance that was occurring downstream; a very high frequency that was occurring. And that was the concern.

JUDGE REED: And that was - in both cases Quad Cities and Dresden, was caused by a recent uprate?

MR. SCARBROUGH: Yes, sir. Both of them occurred in the operating time before that.

JUDGE KARLIN: Yes, my colleagues have

pointed out that it is lunch time, and this panel has been on this hot seat for over two hours, or about two hours, so I think we ought to give them a break too.

So we will take an adjournment until let's say 1:15. We will stand adjourned. Thank you.

(Whereupon at 12:04 p.m. the proceeding in the above-entitled matter was adjourned until 1:15 p.m.)

JUDGE KARLIN: May I remind the witnesses that you're still under oath, so recognize that. I think absent anything from the parties at this point, we'll just continue with the questioning related to Contention Three. Dr. Reed.

JUDGE REED: Thank you. We find ourselves still a little puzzled about the monitoring program, and what you're able to detect. Would you please confirm your earlier statement that you believe that you can detect -

JUDGE KARLIN: And you're addressing this to?

JUDGE REED: I'm sorry. This is to Mr. Hoffman. Would you please confirm your earlier statement that you believe that you can detect a crack prior to any major failure of the dryer through your monitoring program.

MR. HOFFMAN: Yes. The basis for my statement on that was that we have observed that flaw growth, if it's taking place in the dryer, is very slow, so that if we have a situation that occurs that results in a bypass of the dryer through a defect or something that has begun to develop because the flaw growth rate is slow, we will have time to evaluate that condition. And if we determine that the change in parameters is due to a dryer degradation, we would be able to shut the plant down before that propagated to a failure.

JUDGE REED: Can you be more specific as to the size crack that you believe you can detect? What's the minimum size crack? What's the resolution, I think Judge Karlin put it that way earlier, what's the resolution of this monitoring program in terms of the size crack that you believe you can monitor and detect?

MR. HOFFMAN: When you're saying monitoring program, you mean the online monitoring or the inspection part?

JUDGE REED: I'm talking about the online monitoring program.

MR. HOFFMAN: I cannot quantify that, sir.

JUDGE WARDWELL: Could you roughly guess?

Would it be a six inch crack opened up a quarter of an inch, would it be a six foot crack opened up a foot?

MR. HOFFMAN: Can't quantify that.

JUDGE WARDWELL: Do you believe the parameters that you're monitoring are sensitive enough to detect a six inch crack opened up a quarter of an inch? One six inch crack opened up a quarter of an inch.

MR. HOFFMAN: I could not answer that.

JUDGE WARDWELL: You have no feeling on whether it could or couldn't.

MR. HOFFMAN: No, sir.

JUDGE REED: Could we turn to the NRC, for a moment, Mr. Scarbrough. Do you have any opinion with regard to the ability of a monitoring program - now, we're not talking inspection, but monitoring these plant parameters, the particular parameters that have been laid out in the testimony by Entergy, or sudden drop in main steam line flow, difference in reactor vessel water level instruments, and sudden drop in steam dome pressure, do you believe that those parameters would indicate a crack of the size that Dr. Wardwell just specified?

MR. SCARBROUGH: I'm not familiar with the crack size in terms of what -- I know at Quad Cities

Unit 1, they had a crack appear, and that was one of the diagrams that's in the SIL 644 where they showed that event, where the crack was rather long, and a couple of inches, I guess, in size. And you could tell from the plant parameters the moisture carried over the changed air and the distribution of flow within the steam lines changed from that. And from that, they were able to recognize they had issues going on and they shut the plant.

JUDGE KARLIN: How do you know that? I mean, did you work at Quad Cities, or are you reading a report?

MR. SCARBROUGH: No, I was part of the group, when the information came in, because I was assigned to steam dryer program. And so as it came in, we got a report like the Region saying that the parameters were changing, and we got involved, and within a few days they shut the plant down, opened up the -

JUDGE KARLIN: So you were part of the NRC team that was involved with the Quad Cities incident.

MR. SCARBROUGH: Yes, sir.

JUDGE KARLIN: Okay. Great.

JUDGE WARDWELL: And what size did you say, again, about?

MR. SCARBROUGH: It's -- the diagram is in the 644 -

JUDGE WARDWELL: Yes, I don't need that.

MR. SCARBROUGH: It looks like it was a couple of inches wide, and several feet long in terms of the length.

JUDGE WARDWELL: A couple is like six to eight.

MR. SCARBROUGH: Yes. It's hard to tell from the diagram what it exactly was, but it was -- the whole plate was not missing. It was a crack.

JUDGE KARLIN: But are you saying -- okay, so there was a crack there. Were they monitoring according to the parameters that Dr. Wardwell just gave you?

MR. SCARBROUGH: They were monitoring -- I know they saw the change in flow distribution, and that's one of the parameters that -

JUDGE KARLIN: No, but what we're trying to figure out is, this particular protocol, three parameters being continuously monitored, would that have detected this crack, the crack you just described?

MR. SCARBROUGH: I don't -

JUDGE KARLIN: They weren't doing that

monitoring.

MR. SCARBROUGH: I don't remember if those parameters also were changing. All I do remember was the flow distributions in the steam -

JUDGE KARLIN: Well, that's a different parameter.

MR. SCARBROUGH: Yes, sir.

JUDGE KARLIN: It's not even going to be monitored here.

MR. SCARBROUGH: Well, it's one of the parameters that sits in the 644 document, if you look at flow distributions and such.

JUDGE KARLIN: But it's not in what Entergy testified that they were going to be doing. Is it?

MR. SCARBROUGH: It's not one of the ones they call out.

JUDGE WARDWELL: So what you're saying is the distribution of flow is also a monitoring device - device is the wrong word. I don't want to use "parameter" either. Well, I could use parameter, and it just doesn't have any critical limits on it. You just look at that distribution, and if it seems different than it was during normal operations, that would indicate a potential problem.

MR. SCARBROUGH: Yes, the trending is very important, because everything should stay relatively normal and constant. When you see a change like that, operators pay attention and try to determine what's happening.

JUDGE KARLIN: Well, that's all fine and well, but on page 11 of NRC Entergy's testimony, they say they're monitoring three things. They're not monitoring that. Please describe the monitoring program? They say the following events could be indicative, they didn't say will be indicative, of a significant -- A, B, C. So I guess what we're trying to find out is what's the resolution of that program.

MR. SCARBROUGH: Right. I do not know how closely the -

JUDGE KARLIN: Okay.

MR. SCARBROUGH: Identify that issue.

MR. HOFFMAN: May I just clarify one issue? A sudden drop in main steam line flow, there are four main steam lines, so a sudden drop in a main steam line flow would be indicative of a mismatch. If you saw one steam line flow drop, that would be indicative of a mismatch with the other three, potential.

JUDGE WARDWELL: Mr. Scarbrough, I thought

I heard earlier today that at Quad Cities they saw a difference in the moisture carry-over, also. Do you remember anything with regard to -

MR. SCARBROUGH: Yes, they did say -

JUDGE WARDWELL: And that was prior -- that was several weeks or days, or months before they shut down that they noticed this?

MR. SCARBROUGH: Well, this was actually - the event I am familiar with that I was involved with with Quad Cities Unit 1, which is later than the earlier two Quad Cities, too. And there, because of the past experience, when they saw moisture carry-over change, and this flow distribution change, and probably other parameters, as well, that's the only one I recall, but from that, they knew something was happening and they shut down very quickly, within a week or so, they found the dryer was cracked.

JUDGE WARDWELL: Mr. Hoffman, did you design this monitoring program that's presented on page 11 in Answer 24 in order to detect a single crack that is six inches long by a quarter inch wide?

MR. HOFFMAN: I did not develop this monitoring program, no.

JUDGE WARDWELL: Okay.

JUDGE KARLIN: If I can understand the

process of - this is for Mr. Hoffman, I think - these three parameters will be monitored continuously. If a trigger occurs, as you've defined them, then what happens? Someone goes and does a moisture analysis.

MR. HOFFMAN: If any of those parameters fall outside the range, then the first step would be the operators would request a moisture carry-over measurement be taken.

JUDGE KARLIN: Okay. So first thing, any of these triggers hit, moisture carry-over analysis is done.

MR. HOFFMAN: Right. Then they would assess -- they would get the results of the moisture carry-over measurement.

JUDGE KARLIN: And then in Question 32, "Will the plant continue to operate if values of moisture carry-over or other parameters indicate that steam dryer cracking may have occurred?" And you answer, "No." That's correct. Right?

MR. HOFFMAN: That's correct.

JUDGE KARLIN: Of course, I think that question hides a key question in there. What will be the criterion by which it's determined whether the moisture carry-over data indicates that a steam dryer cracking may have occurred?

MR. HOFFMAN: Yes.

JUDGE KARLIN: I mean, presume the conclusion, which is if the data indicates a crack may have occurred, no, it won't continue operating. But what is the criterion by which one looks at the moisture content and say oh, this indicates a cracking may have occurred, this doesn't indicate a cracking may have occurred. There's no objective criterion for that, is there?

MR. HOFFMAN: If the change in moisture carry-over cannot be attributed to a known plant event, or operating mode change, or any of the parameters with moisture carry-over, as well, that would be caused by a known event, we would then get into our operability, or Entergy's operability evaluation process, which brings to bear technical experts on the site, technical experts on other Entergy sites, if necessary, outside consultants would look and see -

JUDGE KARLIN: Well, if it can't be explained by any other mechanism, then you'll shut down the plant.

MR. HOFFMAN: If the conclusion is that we cannot explain it, then the process would be shut the plant down. If it cannot be ruled out that dryer damage has occurred, you would shut the plant down, in an orderly shut down as described.

JUDGE KARLIN: There's no -- can you cite me to any document or criteria that says here is when you shut down the plant, and here's when you don't?

MR. HOFFMAN: As far as -

JUDGE KARLIN: It's a judgment call.

MR. HOFFMAN: As far as moisture carry-over?

JUDGE KARLIN: Yes, sir.

MR. HOFFMAN: It would not be spelled out as a number, because it would need to be evaluated.

JUDGE KARLIN: Okay.

JUDGE WARDWELL: Is that procedure spelled out somewhere?

MR. HOFFMAN: That procedure is a spelled out procedure, yes.

JUDGE WARDWELL: In the -

JUDGE KARLIN: Well, here's -

MR. HOFFMAN: In the ON-3178 then directs to the other procedure, yes.

JUDGE WARDWELL: Okay. There it is. Yes.

JUDGE REED: I would like to follow up a little on this large crack that Mr. Scarbrough mentioned. Can you estimate how long it would have taken that dryer to fail if the reactor had continued to operate?

MR. SCARBROUGH: Well, the dryer had -- in the sense of -- there was flow through -

JUDGE REED: I'm sorry. No loose parts generated though.

MR. SCARBROUGH: Okay. Now, the event that I was involved with, the specific event with Quad Cities Unit 1, November '03. And, actually, that grew out to where there was a loose part, and that was in November 2003, and there was a loose part that came loose with that. So with that event, there was enough flow and such that there was a piece, it was like six inches by nine inches came off and escaped into the main steam system.

JUDGE REED: You described a crack that was about a foot and a half long by several inches wide?

MR. SCARBROUGH: Yes, but -

JUDGE REED: Did I misunderstand -

MR. SCARBROUGH: Yes. I misspoke in terms of the event. The event that we're -- the November 2003 event was a situation where it grew out, and then there was a section that did come loose, so there was -- the November '03 event was Quad Cities Unit 1, and there was a loose part that came out of that.

JUDGE KARLIN: Can you tell us -- the court reporter can't see where your hands are.

MR. SCARBROUGH: Yes.

JUDGE KARLIN: How many inches?

MR. SCARBROUGH: It was a six by nine inch piece. Six by nine.

JUDGE KARLIN: And how about the crack, how big was that?

MR. SCARBROUGH: The crack was several -- it started small and then grew, so it was several feet total.

JUDGE KARLIN: Okay.

JUDGE REED: Is this another crack on another part of the steam dryer, or was this associated with the piece that broke off?

MR. SCARBROUGH: This piece led from an edge over to the sort of middle part of the dryer that faces the main steam line exits, and so it came off on that piece.

JUDGE REED: So a piece was broken off adjacent to this crack that you mentioned. Is that correct?

MR. SCARBROUGH: Yes. The crack grew, and then as it got to the center point of the dryer plate outer hood, a piece did peel off from that location.

JUDGE WARDWELL: And the void left by that piece coming off was part of the size of the crack you described, or was it a piece that was appended to it, and didn't create any more void, or was it another void created?

MR. SCARBROUGH: It's sort of all one continuous void. It started small, then grew at the middle, and then the middle piece came out.

JUDGE WARDWELL: That's part of the description of your several feet by six to eight inches. In the middle portion of that, a solid piece had been removed and went off as a loose part.

MR. SCARBROUGH: Yes.

JUDGE REED: So what we're interested in is how rapidly we can go from initiation of a crack to failure of the dryer with loose parts being generated. In your estimation, if the cause is fatigue, what's that period?

MR. SCARBROUGH: If it's fatigue, it happens very quickly from -

JUDGE REED: Very quickly -

MR. SCARBROUGH: In terms of Quad Cities was 90 days, when they went up in power for their EPU, they passed the point where that acoustic resonance was causing the fatigue limit to be exceeded on the dryer plates, and so it happened very quickly. And then they did some repairs, strengthened it, went up again, and within a year it failed again, Quad Cities Unit 2. Quad Cities Unit 1 operated for about a year at EPU conditions, and it failed, so it happens very quickly. If you're above those fatigue limits, it occurs very quickly, within a year.

JUDGE REED: Okay. And what's the possibility of a crack being initiated through some other mechanism, and then being amplified and leading to failure through fatigue? Is that a possibility, or is that considered?

MR. SCARBROUGH: You do usually start a fatigue crack in some location that has a high stress riser, and that was part of the problem with Quad Cities, is they had these braces inside that caused a stress riser. It helped initiate the crack and get it moving. But you still have to be above the fatigue limits for the dryer to occur. And you have little weld issues and such all -- in the dryer, this big device, this component, you're going to have little places where there's higher stresses than other places, and those could be potential sites to begin a crack. So if you're above the fatigue limit, you're going -- it's going to find a site to go ahead and start propagating. And here, the analysis was shown that they were below the fatigue limit with additional uncertainties included. And then they'd be monitoring every outage looking to see if there's any issues happening in the dryer, and so far as the last one they had seen. So that's part of the extra conservatism of making sure that all of those analyses were reasonably accurate. We know there's uncertainties, but we want to make sure that they're still below the fatigue limit, and they see that through the inspection.

JUDGE REED: So may I take what you just said as supportive of the contention that Entergy put forward earlier today, that since they've operated for - how long - two years?

MR. HOFFMAN: A little bit over two years.

JUDGE REED: A little over two years at the 20 percent uprate, it's very unlikely that a fatigue -- it's very likely that if they had had a situation where a crack was going to develop due to fatigue, it probably would have already developed in that two-year period. Is that correct?

MR. SCARBROUGH: Yes, sir.

JUDGE REED: So you confirm their -

MR. SCARBROUGH: Yes, sir. Their finding small little -- they had been in there in the past and they have not grown, and so this was the additional confirmation that the analyses, that they really are below the fatigue limit for the material.

JUDGE REED: Dr. Hopenfeld, did you have -

DR. HOPENFELD: Yes. I gave one example before, but maybe too general about why, the rationale that -

JUDGE REED: I'm having trouble hearing you.

DR. HOPENFELD: I gave one example before as to why the rationale that one inspection is not sufficient without doing, without showing the calculations. It's not sufficient to demonstrate that you are not going to have failure later on. The only way that one can do that, because so many parameters coming into this, is very, very plant-specific. The only way you can do that is by doing the calculations, or instrumenting the dryer. But let me give you another example, because I gave you a very general example.

Suppose that the requirements was that you inspect the dryer every three months, so you inspect it the first three months, and you look at it and say well, nothing happened. Would you be able to conclude without anything else that nothing is going to ever happen forever? Obviously, not. Then you go to the six month, where do you draw the line? The only way you can draw the line is with calculations. There's no other way of doing it, because so many -- what you have, you have the natural vibration of the different components of the dryer, the location, the different possibility of sources, and the different designs. This design is different. Plus, there were modifications in the dryer, also. So you just can't -- I mean, it's impossible to take one situation that happened in November and say well, I can conclude that's the time scale.

JUDGE KARLIN: But, Dr. Hopenfeld, I still am troubled by this. It's my understanding that they're not trying to say it will never happen. The program is there to detect if it does happen, so that action can be taken in some time frame to shut the facility down, or do whatever is necessary. They're not trying to say it won't happen. They're trying to detect it if it does, and then take action.

DR. HOPENFELD: Okay. I was addressing the first part, now let me address this one. General

Electric concluded in SIL NO-644 on page 6, they concluded from the November 2003 experience that the failure -- they're referring to the November 2003 experience, that monitoring steam moisture content and other reactor parameters does not consistently predict imminent dryer failure.

JUDGE KARLIN: Yes, sir.

DR. HOPENFELD: Does not. And that's -- I don't know what else he's going to say.

JUDGE KARLIN: I agree. I had that very provision on page 6 of SIL 644 underlined. The November 2003 hood failure - is this the one you're referring to, Mr. Scarbrough?

DR. HOPENFELD: Yes.

JUDGE KARLIN: Mr. Scarbrough?

MR. SCARBROUGH: Right. Yes, sir.

JUDGE KARLIN: That's the one you were involved in. "Demonstrated that monitoring steam moisture content and other reactor parameters does not consistently predict imminent dryer failure. My question is they're not trying to predict. They're trying to detect it, so that action can be taken.

DR. HOPENFELD: No, it says it doesn't detect it either.

JUDGE WARDWELL: Where does it say that?

DR. HOPENFELD: Well, it doesn't need the work, the indication it doesn't detect.

JUDGE KARLIN: Well, I think, as I understand it, Entergy is positive that they're not trying to predict, they're trying to detect. So is this a non-issue?

DR. HOPENFELD: Well, if that's the case, then what they would have to do - this is a general statement off the detection co-exhibit, because if you detect, you know -- maybe they need to fill out -

JUDGE KARLIN: Well, let me back up. As I understand your counsel's position, your position is they need to predict it.

DR. HOPENFELD: Correct.

JUDGE KARLIN: They're saying they don't need to predict it. They just need to detect it.

DR. HOPENFELD: Well, if that's the case, sir, I believe that they should be able to answer the question that was brought here, is to tell me what is the size of a crack, the minimum size of a crack and its location. You have to realize, there are many, many locations these cracks can happen, and that may be a long time for that steam to find itself somewhere you could measure it, or you need to see a level change, so you have to do a parametric study, sensitivity study to show me. I haven't seen any of that, and I don't believe that you have seen any of that. So all we hear with the gentleman just talking, I mean, they're giving you an opinion completely based on their feel. They don't -- I mean, this is not engineering. You know, this is just not engineering what you're hearing here.

JUDGE KARLIN: Well, let me ask, what are we trying to predict, what are we trying to detect? It seems to me that we're not -- there's something between dryer failure and a crack. It's not either one of those, it seems to me. It seems to me what we're concerned about is a threat, or a problem with regard to the safety. And as I understand it, if such a problem would arise, if a piece breaks off, drops down, gets into some valve somewhere and causes a problem, so that's not a crack, that's a piece breaking off. And it's not failure of the whole steam dryer either. It's something in between there.

DR. HOPENFELD: Correct.

JUDGE KARLIN: And so the fact that they can't detect a crack of X amount, or a steam dryer total collapse failure, I don't know what the definition of failure is. There's more -- are they going to be able to detect a piece dropping off such that if it -- anything that might affect safety, something -

DR. HOPENFELD: I'll tell you, if somebody gave me a job, I was making some time to do that, and somebody would ask me okay, just answer that question. I'll start with a piece of paper. I'll start with this a different size of crack, different location, and then find out how many of those do I need, what's the total surface, I mean opening area that I need for me to detect it at Point A, B, and C, whatever, whatever they detect. The next thing I'm going to do is take a look at these cracks and see what kind of geometry configuration or topography I need for these things to cause a loose part. If I have a little part here, and a little crack somewhere far away, maybe this is a single crack, maybe that's not going to cause any rupture. Maybe that by itself, you detect it, that's fine. I'd like to tell you that everything was -- they say doesn't make sense. Some of it does, because it does a certain amount of that, but that's not how you look at safety.

JUDGE WARDWELL: How are your calculations going to result in anything better in regards to -

DR. HOPENFELD: Well, because I'll tell you, what -

JUDGE WARDWELL: -- any prediction, because it's just supposition of where you happen to select the -

MR. HOFFMAN: Right. But that's all you can do. I mean, then you say look, you're going the probability, probabilistic basis on that. You would say well -

JUDGE WARDWELL: What then would you use to support the probability of a failure occurring, a crack in a given location?

DR. HOPENFELD: You have to see what's the minimum amount of cracks they need -

JUDGE WARDWELL: What data are you going to use to select -- to indicate the probability at a given location? You don't have any, do you?

DR. HOPENFELD: Yes, I have -- well, what data are you asking me? I haven't started working on that problem. I believe that's their job.

JUDGE WARDWELL: Yes, but think about it.

DR. HOPENFELD: What data?

JUDGE WARDWELL: You would need some observational data -

DR. HOPENFELD: You need calculation to see how fast these cracks grow, and how they form.

JUDGE WARDWELL: You can't make up the

calculations in a void in a probability risk assessment. You have to -

DR. HOPENFELD: No, no, but stuck with crack, you come up with some assessment. You're going to look at how you stress the area to begin with. You're going to look at existing cracks. That's how you're going to start.

JUDGE KARLIN: Doctor, may I just -- let's just double check here. Mr. Scarbrough, perhaps I could ask you if you agree with this, which is the statement out of SIL 644, page 6. It was quoted earlier. I won't read it. I'll quote, "The November 2003 BWR-3 hood failure demonstrated that monitoring steam moisture content and other reactor parameters does not consistently predict imminent dryer failure, nor will it preclude the generation of loose parts." Do you agree with that statement?

MR. SCARBROUGH: Yes, I agree with that statement.

JUDGE KARLIN: Okay. Mr. Hoffman from Entergy, or Mr. Lukens, do you agree with that statement?

MR. HOFFMAN: Yes, sir.

MR. LUKENS: Yes.

JUDGE KARLIN: Okay. The next statement

is, "Monitoring is still useful in that it does allow identification of a degraded dryer, allowing appropriate action to be taken to minimize the damage to the dryer and the potential for loose parts generation." Do you agree with that, Mr. Hoffman?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: Mr. Scarbrough?

MR. SCARBROUGH: Yes, I do.

JUDGE KARLIN: Dr. Hopenfeld?

DR. HOPENFELD: In general, yes.

JUDGE KARLIN: You agree with that. So we're all in agreement.

DR. HOPENFELD: In general, yes.

JUDGE KARLIN: Okay.

JUDGE REED: Okay. I would like to focus now on the inspection component of this program. I don't know whether you consider inspection as part of the monitoring program, or separate.

MR. LUKENS: There's probably some confusion about that, because what we referred to as the steam dryer monitoring plan contains both online monitoring and inspection.

JUDGE REED: I see. Okay. So, to date, we've been talking about the online monitoring.

MR. LUKENS: Yes, sir.

JUDGE REED: I would now like to talk about the visual inspections that you do. Before we begin, maybe we should talk about existing cracking of the dryer. It's my understanding that cracks have been observed in the dryer, and been repaired. Is that correct?

MR. LUKENS: Yes, sir.

JUDGE REED: Could you briefly describe what the -

MR. LUKENS: A brief history?

JUDGE REED: Yes.

MR. LUKENS: The first comprehensive examination of the dryer was in 2004 in anticipation of power uprate. That examination found 20 indications by visual examination. Of those 20, two were determined that they needed repairs. We ground them out and re-welded them.

JUDGE REED: Well, why would a particular crack need repairing and another one would not?

MR. LUKENS: The decision about whether a crack needs to be repaired or not goes to how big is the section that it's in, and what is the critical size for a flaw in that location, and how fast using standard methodology, how fast will that crack grow, and how big will it be at the end of 18 months, the next refueling outage?

JUDGE REED: So what kind of methodology would predict that rate of crack growth?

MR. LUKENS: The rate of crack growth inter- granular stress corrosion cracking, IGSCC, the industry-accepted number is 5 times 10 to the minus 5^{th} inches per hour, which roughly translates to something on the order of half an inch a year.

JUDGE REED: So you assumed that all of the cracking that was observed was inter-granular stress corrosion cracking?

MR. LUKENS: No, sir, we did not assume that it was inter- granular stress corrosion cracking, we observed that. It is possible.

JUDGE REED: What are the characteristics -

JUDGE WARDWELL: It's possible what?

MR. LUKENS: To determine by visual examination whether a crack is IGSCC or petite.

JUDGE WARDWELL: And what is that visual indication?

MR. LUKENS: IGSCC typically occurs in the heat affected zone adjacent to a weld, because that's the area that's been sensitized. IGSCC requires stress and the right material properties, and the right environment to cause it to propagate. The heat affected zone adjacent to a weld in austenitic stainless steel typically has the right material to propagate an IGSCC crack.

The dryer was essentially cold formed and welded together, so that there are very large residual manufacturing stress, so we anticipate finding IGSCC cracks in the dryer, and we did. A petite crack - let me characterize an IGSCC crack.

Inter-granular stress corrosion cracking goes between grain boundaries, therefore, the appearance of an IGSCC crack is going to be jagged. A petite crack tends to be a straight line, and based on where the crack is; that is, is it in a high-stress, low-stress area, is it in heat affected zone, is it crooked or is it straight? We can tell whether a crack is IGSCC or petite.

JUDGE WARDWELL: And all of these were?

MR. LUKENS: All of these were IGSCC.

JUDGE WARDWELL: IGSCC.

MR. LUKENS: Yes, sir.

JUDGE WARDWELL: Did any of them penetrate the entire thickness?

MR. LUKENS: IGSCC cracks are typically very tight so that we can't actually determine depth.

For purposes of analysis to determine whether it's acceptable to run another 18 months, we assume the crack goes all the way through.

JUDGE REED: Okay. You were in the process of doing -

MR. LUKENS: I'm sorry, yes. That was 2003. 2005, we did an augmented partial examination. We had not yet reached uprate conditions.

JUDGE KARLIN: May I stop you for a moment?

MR. LUKENS: Yes, sir.

JUDGE KARLIN: If I may, and say maybe we could -- while you're talking, I'm reading your testimony on this.

MR. LUKENS: Yes.

JUDGE KARLIN: This is page 22 of your staff exhibit, or Entergy Exhibit 01, which is now, of course, in the record. I'm following your testimony, page 23, we're at the 2005 refueling outage.

MR. LUKENS: Yes, sir.

JUDGE KARLIN: Fall of 2005.

JUDGE WARDWELL: We've been under the power uprate now for -

MR. LUKENS: The outage of 2005 was prior to uprate. We had not -

JUDGE WARDWELL: Prior to.

MR. LUKENS: -- yet achieved uprate conditions.

JUDGE WARDWELL: And what number was this?

MR. LUKENS: This was RFO-25.

JUDGE WARDWELL: Okay.

MR. LUKENS: We did an augmented examination of the dryer; that is, it was larger than the required scope by the BWR VIP, but it was less than all accessible susceptible areas because we had just done one of those the previous outage. And since we hadn't achieved uprate conditions, nothing had changed, so we performed the examinations. We found 66 indications in the dryer in that examination. It's worth pointing out that we found 66 indications, even though the actual number of exams was significantly less than it had been in 2004. The reason for that is that the examination quality in 2005 was superior to what we got in 2004.

A VT-1 examination, which is what we do, has a specific resolution requirement to meet the -- to be called a VT-1. The examinations in 2004 met that requirement. The examinations in 2005 exceeded that requirement. And, as a result, their resolution was much better than the resolution in 2004, and we found a lot of indications.

JUDGE REED: Do you recall off the top of your head what is the resolution requirement of a VT-1?

MR. LUKENS: VT-1 requires, and this is also in testimony, VT-1 -

JUDGE REED: I've listened to the testimony but I've forgotten.

MR. LUKENS: VT-1 requires that we be able to distinguish a point zero or four inch lower case character without ascenders or descenders. That would be, for example, an A, an O, an E.

JUDGE REED: Yes.

JUDGE WARDWELL: .044, 44 thousandths?

MR. LUKENS: 44 thousandths of an inch, and I struggled before these hearings began to try to make that mean something. It turns out that 44 thousandths of an inch is slightly larger than the micro engraving on a dollar bill.

JUDGE KARLIN: So the difference between the 2004 and 2005 detection of indications was not a function -- I thought 2004 was a VT-3 exam, and the 2005 was a VT-1.

MR. LUKENS: No, sir.

JUDGE KARLIN: No, they're both VT-1s?

MR. LUKENS: They were both VT-1s.

JUDGE KARLIN: But this was sort of VT-1 plus, even better than -

MR. LUKENS: Yes, sir. That's a good way to characterize it.

JUDGE KARLIN: Okay.

JUDGE REED: Is the surface condition of this dryer after 30 something years of operation such that you can see cracks, or is the surface rather eroded, or is it hard to see a crack? Is it a nine shiny surface and you can see a crack, or -

MR. LUKENS: There are places that are nice and shiny. There are places where there are corrosion products, and more recently, some residue from noble metals treatment, which in some cases makes a surface examination a little more difficult. However, despite that, using the VT-1 plus, if I may, we found a lot ore indications in 2005 than we did in 2004. We found all of the 2004 indications, and none of them had grown. We also examined the modifications made in 2004, and the two repairs that we made in 2004, and there were no indications.

In 2007, we did another comprehensive exam of all susceptible areas, so this was the same scope as the 2004 exam. Under the resolution requirements that we achieved in 2005, we specified to the examiners that they had to be able to see as well in 2007 as they did in 2005. We weren't going to take a sort of bottom acceptable VT-1. We'd already seen what we can get with a better exam, and we wanted it.

We got 66 indications, 66 relevant indications in 2007. We found 48 of the previous indications, none of them had grown. We found 28 new ones, which were all IGSCC, and were all dispositioned, use as-is, and there were 9 indications from 2005 that were determined in 2007 to be non-relevant indications.

(Clock chime.)

JUDGE REED: -- as a non-relevant -

MR. LUKENS: A non-relevant indication is something that does not produce a surface irregularity within the resolution of a VT-1 examination. What that really means is they went to the location where there had been an indication the previous outage. But one indication that I'm particularly familiar with, they illuminated it from the left-hand side, and it looked just like it had in the previous outage. They illuminated it from the right-hand side, and the indication went away. It was a shadow, so that became a non-relevant indication.

JUDGE KARLIN: You talked in your testimony, sir, written testimony about recordable. Is that the same as -- when you say "relevant", it seems like a new term to me, as opposed to "recordable". Is it the same or different?

MR. LUKENS: Relevant is the correct terminology in non-destructive examination. All relevant indications must be recorded. In addition, we may record indications that turn out to be not relevant. And I apologize for the confusion.

JUDGE KARLIN: No, I was just confused, because on page 20 you testified that "an indication is classified as recordable or relevant if it is visible to the resolution of the examination technique."

MR. LUKENS: That is correct.

JUDGE KARLIN: Okay. And so those are interchangeable terms in this sense?

MR. LUKENS: Yes, they are.

JUDGE KARLIN: Recordable and relevant?

MR. LUKENS: Yes.

JUDGE KARLIN: All right.

JUDGE REED: So what's a VT-3 inspection, and when would you use that?

MR. LUKENS: A VT-3 inspection does not

have the same resolution requirements as VT-1. VT-3 is a more general examination for looking at material condition, and it is typically used in visual examination of other reactor internal components other than the steam dryers. In earlier times, the dryer was examined by VT-3, but in the recent past, certainly the last three outages at Vermont Yankee, dryer examinations have been by VT-1.

JUDGE REED: Are all the locations on the steam dryer where cracks could potentially form subject to inspections? Can you see everywhere that you need to see?

MR. LUKENS: Yes, sir, you can. The areas most susceptible to failure are the outer surfaces of the steam dryer, vertical, the sides, cover plates. Those are all on the exterior, and they are easily accessible, so all of the susceptible areas are accessible.

JUDGE REED: All right.

JUDGE KARLIN: So there's only been -- since the uprate, there's only the Spring 2007 visual inspection event?

MR. LUKENS: That's correct. Spring 2007 was the first inspection -

JUDGE KARLIN: The next one is due?

MR. LUKENS: -- following uprate. We'd been operating about a year.

JUDGE KARLIN: And the only one since the uprate.

MR. LUKENS: And the only one so far.

JUDGE KARLIN: Okay.

MR. LUKENS: The next one will be in October this year.

JUDGE KARLIN: Okay.

JUDGE WARDWELL: Referring to the SIL 644, page 6, A-1(c).

MR. LUKENS: Yes, sir.

JUDGE WARDWELL: It says, "Flaws left as-is should be inspected during each scheduled refueling outage until it has been demonstrated that there are no further crack growth and the flaws have been stabilized."

MR. LUKENS: Yes.

JUDGE WARDWELL: Are all of these crack detections considered flaws?

MR. LUKENS: Yes. We do not distinguish between -- for the purposes of complying with the SIL, we don't make a distinction between an indication, a flaw, and a crack. If it's big enough to see in a VT-1, we record it as relevant and we track it to verify that it's not growing.

JUDGE WARDWELL: What is the definition of a demonstration that no further crack growth is occurring, and the flaws are stabilized?

MR. LUKENS: Our position, which is consistent with ASME and the industry, is that if a crack is shown not to be growing in the two inspections following its initial discovery, it's not growing, and need not be inspected.

I point of fact, we haven't even had a discussion about not looking at old indications, because all of -- since we're doing comprehensive dryer examinations, we're going to be there anyway, so we just continue to look for those indications, record their size, and compare them to what they were.

JUDGE REED: Is there any role for ultrasonic testing? I know this is done -- we talked earlier in this hearing about testing of a feedwater nozzle, and completely different techniques are used. I just would like to know why on some locations in the reactor you use different techniques to look for cracks. Why here is it strictly visual?

MR. LUKENS: Ultrasonic techniques are typically used on pressure-retaining components, like feedwater nozzles and reactor cooling system lines.

The steam dryer is a non-pressure-retaining component.

JUDGE REED: What's the reason for that? Is it more sensitive, a higher resolution, can it detect the depth of a crack, or -

MR. LUKENS: Ultrasonic can do a lot of things, but it's not an unmixed blessing. It may show things in a piece of stainless steel that are not flaws, they're called reflectors.

JUDGE REED: So you get false positives?

MR. LUKENS: We get false positives. And the consensus is that visual examination at the VT-1 standard is the right test for determining dryer integrity.

JUDGE REED: And when you talk about crack growth, you can't see the depth of the crack, so you're really talking about the longitudinal -

MR. LUKENS: That's correct. The only visual we have is length. We assume that it's all the way through.

JUDGE REED: Okay.

JUDGE KARLIN: Can I ask a question? On page 25 of your testimony, this is part of the testimony I think you corrected.

MR. LUKENS: Yes.

JUDGE KARLIN: But my question is not

directed to any of the corrections, I don't think. And you discussed earlier in your testimony that the total number of examinations that you conducted in the 2007 inspection were greater.

MR. LUKENS: Yes.

JUDGE KARLIN: Significant, 463, than the total number of dryer exams in 2005, which is 113, and 2004, which is 287. Presumably, is it laid out somewhere, how many -- can you just do as many as you feel like, or what's the standard for how many dryer exams will be done each time there's a refueling outage?

MR. LUKENS: The standard for how many dryer exams will be done, if I may simply address the -

JUDGE KARLIN: Well, obviously, you have to look at the cracks that were existing before to see if they're grown.

MR. LUKENS: That's correct.

JUDGE KARLIN: But maybe that's sort of a baseline, and then -

MR. LUKENS: That's actually a small piece.

JUDGE KARLIN: Yes.

MR. LUKENS: The fundamental scope using

SIL 644 is all the accessible susceptible areas. And the SIL shows in color diagrams where the susceptible areas are. However, the SIL is somewhat generic in its reference to weld numbers, so it is the job of the program engineer to take those diagrams and distill out of them all of the weld numbers in our dryers. It's a very site-specific number. All of the weld numbers in our dryer need to be examined.

JUDGE KARLIN: But then shouldn't this number be the same for each one of the exams, because the non-relevants aren't going to change for Vermont Yankee.

MR. LUKENS: That's correct. The 2005 exam, as I said, was not a comprehensive exam. It was an augmented exam, but not comprehensive. And the difference between 2004 and 2007, we both had the same requirement of accessible susceptible.

JUDGE KARLIN: Oh, yes.

MR. LUKENS: The difference between those is that different companies perform those two sets of exams, different people count an exam a different way, and in one case one weld may be one examination, in another case a weld may be two examinations, and so it -- we have struggled with this. And with experience, we have identified by examination number all of the welds that are in the scope. And I would expect in this fall that that number that we examined in 2005, 463, very, very close to the actual count in 2007.

JUDGE KARLIN: And you have this done by an outside contractor, I think your testimony, typically.

MR. LUKENS: Typically do, yes.

JUDGE KARLIN: Did you change your contractors between the -

MR. LUKENS: Yes, we did.

JUDGE KARLIN: -- two events, 2005, 2007?

MR. LUKENS: And we changed again between 2005 and 2007.

JUDGE KARLIN: Okay.

MR. LUKENS: But the burden of establishing the scope and deciding what gets looked at is our's. That's the program engineer's job.

JUDGE KARLIN: All right.

MR. LUKENS: The company that we call in to do the exam simply performs the exams we tell them to do.

JUDGE KARLIN: It doesn't seem like it should change that much.

MR. LUKENS: It doesn't seem like it should change that much, 100 percent should be 100 percent.

JUDGE KARLIN: Yes.

JUDGE WARDWELL: Can you comment somewhat in regards to the potential for the IGSCC cracks to provide a basis, or a logical location for additional cracking and crack growth associated with fatigue?

MR. LUKENS: Yes. For an IGSCC crack to become a site for fatigue failure, it has to occur in a high-stress area. It has to occur in an area that had been subject to cyclic stress loads that exceed the endurance limit. To-date, we have never found an indication in a high-stress area of the dryer. IGSCC indications we have found have been in low-stress areas of the dryer, which is another way of confirming that, in fact, they're not really -

JUDGE WARDWELL: May I refer you to NEC JH-68, which is -

MR. LUKENS: Yes, sir.

JUDGE WARDWELL: It's probably some other number, but it's your condition report of May 28th, '07, 2133 did you say?

MR. LUKENS: Yes.

JUDGE WARDWELL: Yes, that's the CRB VTY 2007-002133.

MR. LUKENS: That's correct.

JUDGE WARDWELL: Yikes, a quarter of inch of pages into that - I can't go any further - where it's evaluation of steam dryer indications.

MR. LUKENS: Yes, sir.

JUDGE WARDWELL: It's probably the first real page of text, full text.

MR. LUKENS: Yes. Let's see.

JUDGE WARDWELL: Probably going to guess my question.

MR. LUKENS: I hope so.

JUDGE WARDWELL: And I'm looking at the section that's entitled, "Evaluation of indications", the third section down, "Introduction, Discussion, and Evaluation of Indications." The first paragraph, one, two, three, four, five, six, seven, eight lines - seven lines down, one word in, the sentence starts, "However, continual growth by fatigue cannot be ruled out in regards to these", I assume it's in the -

MR. LUKENS: Yes, that's what it says.

JUDGE WARDWELL: Would you like to comment on what does that mean? That seems to indicate to me that you found something, an IGSCC that you referred to in the first sentence of this evaluation.

MR. LUKENS: This wording was part of what became a -- part of a draft that became a signed issued report. This page is not part of a signed report. This page was used to clear an outage constraint so that this indication would not cause us to delay start-up. The standard of rigor for what it takes to clear an outage restraint is different than the standard of rigor that it takes to perform the actual investigation and corrective action for a condition report. And that standard of rigor was met in the corrective action to investigate and correct this. And the document that did that is - actually, it's in front of the page that we're reading from - the document that did that is VY-RPT-07-00011. That is the -

JUDGE WARDWELL: You lost me on where this document is.

MR. LUKENS: Yes. About a 16^{th} of an inch ahead of where you are.

JUDGE WARDWELL: Hah-hah, something I understand.

(Laughter.)

JUDGE WARDWELL: I gotcha. Yes.

MR. LUKENS: That's the final report, an engineering report by Vermont Yankee, that dispositioned this indication. The phrase that appeared in the draft does not appear in the final report, and the reason that phrase does not appear is because that phrase added no engineering or technical value to the conclusions in that report.

JUDGE WARDWELL: But yet, someone made this statement, and is it a false statement?

MR. LUKENS: It's not false in the sense that there are millions of things that could not be ruled out. It raises a question that didn't exist.

JUDGE WARDWELL: Because of your previous testimony that this crack or cracks that this was referring to was not in a location for high -

MR. LUKENS: That is correct.

JUDGE WARDWELL: -- stresses.

MR. LUKENS: That sentence lended an air of ambiguity that the engineering evaluation did not support. We knew that these were IGSCC cracks.

JUDGE WARDWELL: Clarify for me then, again, why was it in the draft, that it was just a stream of consciousness writing that someone just added that, or was it something else?

MR. LUKENS: That occurred on the first of June. That's the date that the corrective action was cleared.

JUDGE WARDWELL: What year?

MR. LUKENS: 2007. This was actually

during the outage. And I simply don't recall conversations that we had around that time.

JUDGE WARDWELL: How come it's not marked "draft" anywhere, or is it? Point to me where it is.

MR. LUKENS: It's actually not marked at all. It is simply a piece of paper that was attached to a corrective action to close it, and that was accepted by flight management as adequate justification to clear that outage. But it is not, in any sense, an engineering evaluation.

JUDGE WARDWELL: Are you all done? Yikes, now we're not going to be as organized as Dr. Reed. I'd like to go back, if we could, to talk about the practicality of measuring stress loads directly on the steam dryer.

MR. LUKENS: Yes, sir.

JUDGE WARDWELL: Is that a feasible thing to do?

MR. LUKENS: Not in our view. No, sir.

JUDGE WARDWELL: And why not?

MR. LUKENS: It would involve attaching strain gauges to the dryer, and those strain gauges would have to be attached by welding, so if the attachment of the strain gauges introduces high-stress areas in the dryer that didn't exist before, then the electrical wires from those strain gauges have to be led out of the reactor vessel. All of that paraphernalia becomes potentially loose parts.

JUDGE WARDWELL: But there is internal monitoring of the core, isn't there, within there, and they have that same challenge, don't they, in regards to getting wiring out of the -

MR. LUKENS: Core monitoring that involves instruments that have wires coming out of the reactor vessel is nuclear instrumentation. And nuclear instrumentation goes in from the bottom of the vessel, and the wires come out the bottom. And those detectors are not in the steam flow path, and we don't have to put tack welds on components to get them installed.

JUDGE WARDWELL: Are those the only instruments that are inside the reactor vessel, are those core detectors that have external leads coming out?

MR. LUKENS: Those are the only ones that I can think of. Pressure and level detectors are a different set of instruments, and they don't have any analog to nuclear instrumentation, or to strain gauges.

JUDGE WARDWELL: But how do they work?

MR. LUKENS: Well, the way they work is -

JUDGE WARDWELL: This is the other ones, the pressure levels, or the water levels?

MR. LUKENS: Pressure level, essentially, we -- well, pressure, we have a little pipe that comes out of the side of the reactor, and we put a pressure gauge on it, very simple.

JUDGE WARDWELL: So that's external.

MR. LUKENS: External. Water level, we essentially do that twice. We do it once low, and once high, and -

JUDGE WARDWELL: It's a manometer.

MR. LUKENS: And it's a manometer.

JUDGE WARDWELL: Mr. Hoffman?

MR. HOFFMAN: The nuclear instrumentation that goes in the bottom of the vessel doesn't enter the water. It's in what they call a dry tube. It goes up and down, so it's not exposed to reactor temperature or reactor pressure.

JUDGE WARDWELL: These difficulties are circumvented by measuring within the steam line, is what you did during the power uprate.

MR. LUKENS: That's correct.

JUDGE WARDWELL: That is feasible to do, because you did it already.

MR. LUKENS: We did it. Yes, sir.

JUDGE WARDWELL: The drawback is now you have to have some type of mechanism to extrapolate that data into what the pressures would be in at the steam dryer. With that information, you'd have to -- from that monitoring, from that information, you'd have to extrapolate to what the measurements would be in at the steam dryer in order to be of any use.

MR. LUKENS: That's the process that was used during power extension. Yes, sir. Strain gauge data was manipulated into ultimately cyclic pressure sources.

JUDGE WARDWELL: And if one was to consider augmenting an aging management plan to include some type of mechanism to determine the stresses on the dryer, and were going to conclude that the only reasonable way to do it was to remotely measure them in the steam line, and then extrapolate to what they would be in the steam dryer, you'd have to come up with a mechanism to do that extrapolation.

MR. LUKENS: Yes, sir, we would. I think that assumes that we need to.

JUDGE WARDWELL: Correct. That was where I was going with the next question. Dr. Hopenfeld, of what use would these stress measurements be on the steam dryer as an aging management plan to -- what incremental use would there be of this?

DR. HOPENFELD: Would be tremendous incremental use because, to answer the question of being able to -

JUDGE WARDWELL: Speak up.

DR. HOPENFELD: It would answer the question where are you with respect to the endurance -

JUDGE WARDWELL: Don't the inspections do that for us?

DR. HOPENFELD: No, they don't.

JUDGE WARDWELL: Let me finish. Let me finish my question so that you can know what you're answering.

DR. HOPENFELD: Yes.

JUDGE WARDWELL: Do not the inspections do that if they demonstrate that, in fact, there are no fatigue cracks?

DR. HOPENFELD: No.

JUDGE WARDWELL: That the endurance level hasn't been exceeded?

DR. HOPENFELD: No, they do not, because it depends on the number of cycles, and it depends on the load.

JUDGE WARDWELL: How many cycles are needed?

DR. HOPENFELD: Well, I couldn't answer how many cycles, it depends on the load. It depends on what the -- the intensity of the pressure in the dryer.

JUDGE WARDWELL: How long, in your professional opinion, do you think stress loads would have to be monitored - I mean, sorry - strike that - how long, in your opinion, do you believe that observations of no cracking associated with vibration fatigue would have to occur before you would be comforted that, in fact, the endurance limit is not being exceeded under the normal power uprate that now exists?

DR. HOPENFELD: I thought a lot about that question myself before I -

JUDGE WARDWELL: Well, you must have an answer then.

DR. HOPENFELD: Yes, well, I don't. I'll tell you, because I could give you the answer that I want, that the problem is -- first you have to realize you're not talking -

JUDGE WARDWELL: I don't want any answer I want, I would like to know what is your professional opinion.

DR. HOPENFELD: I do not have one.

JUDGE WARDWELL: Anyone from the staff who feels they wish to answer that question, feel free to.

MR. SCARBROUGH: Well, in the power uprate license condition, we require three consecutive inspections to look for any cracking that might occur from a fatigue, or any type cracking. But they had to do three full inspections, and that was the license condition that we had.

JUDGE WARDWELL: So to translate that indirect answer, you believe a time frame over which three inspections could take place would be sufficient to comfort the staff that fatigue -- that the stress loads are below the endurance limits if there's no fatigue cracking.

MR. SCARBROUGH: Yes. And then you go into the long-term program after that, like the SIL, more graded approach. But every outage, the first three they have a look, and then after that they go into something, a longer -

JUDGE WARDWELL: Under the current steam dryer management program, Rev. 3, steel trap mind, what action would take place if, in fact, some fatigue cracking is observed over the next two cycles? So there's two more cycles left to go. Right? They've done one.

MR. SCARBROUGH: Yes, sir. That would initiate an engineering evaluation of what the source of that fatigue crack was, because they should not be seen. And if they did, they would have to evaluate that before they started the plant back up. They need to determine what that was, see if they need to do repairs in the dryer. And it would reopen that whole question, because they should not be seeing any fatigue-type cracks. And if they did, that would open up -

JUDGE WARDWELL: Have you reviewed the 2006, is it, results, refueling outage 26?

MR. SCARBROUGH: 2007?

JUDGE WARDWELL: Yes, 2007, the most recent.

MR. SCARBROUGH: Yes, the most recent one. Yes, they presented those to a team of staff and our consultants, and we looked through all of those, and discussed those with them, and the NRC staff decided that there was no significant issues, and there were the small little things that they saw. But it was very typical. You see that typical when you do steam dryer inspections, there was nothing there that showed any type of fatigue related to a power uprate.

JUDGE WARDWELL: Okay. Did the staff have any concerns with regards to the statement that this draft condition report that stated "fatigue cracking at these locations of inter-granular stress corrosion cracking cannot be ruled out." Did that create any concerns for the staff?

MR. SCARBROUGH: No. From the discussions, we do not have a concern with that. And from the final decision, that there was nothing significant going on in terms of the discussion.

JUDGE WARDWELL: The discussions you had were similar to what was presented to this Board this afternoon -

MR. SCARBROUGH: Yes, sir.

JUDGE WARDWELL: -- in regards to the -

MR. SCARBROUGH: They would go through every indication, and the staff would look at them, and discuss them with the licensee.

JUDGE WARDWELL: Turning to Entergy, I assume you agree that certainly no more than three are needed. Is that correct?

MR. SCARBROUGH: Yes, sir.

JUDGE WARDWELL: You may take an even more liberal position, but you certainly don't feel more is needed.

DR. HOPENFELD: Could I continue in part to answer your question.

JUDGE WARDWELL: I thought you answered it.

DR. HOPENFELD: Well, I didn't really complete it.

JUDGE WARDWELL: You answered to my satisfaction. Go ahead.

MR. HOFFMAN: I didn't give a complete answer, because if there was a simple answer to your question, sir, then I don't think that GE would be considering instrumenting their dryer and the steam lines at the same time in their advanced reactor on their prototype, because they may have a different design. I'm not familiar with the design. But the issue that was brought up about loose parts can be there, no matter what the design, and I was going to get to there, but I -

JUDGE WARDWELL: Thank you. Dr. Hopenfeld, in your engineering experience, specifically outside of the nuclear field, if you have any interactions with other engineers or understand what they do, if you ever heard of monitoring for stress conditions as a tool to evaluate the performance to insure it's consistent with design of an engineered facility.

DR. HOPENFELD: Well, one of them -- I think probably a lot of them, I know -- I think it should be here for the University of Vermont had a fiber optic program for installing fiber optic cables, fiber optic monitors to monitor fatigue and structure integrity. That's one sense. The problem is that the number of places these people -- really, that's very important. But that's one, done on a large industrial basis.

JUDGE WARDWELL: Thank you. Dr. Hoffman, can I refer you to NEC JH-63 at 34, and I think it's in relationship to ACRS questioning.

DR. HOPENFELD: Are you talking to me?

JUDGE WARDWELL: No, no, I'm sorry. Mr. Hoffman. We have way too many H witnesses.

MR. HOFFMAN: Could you repeat the page for me, sir?

JUDGE WARDWELL: 63.

MR. HOFFMAN: Yes.

JUDGE WARDWELL: At 34.

MR. HOFFMAN: 34.

JUDGE WARDWELL: I hope I don't surprise myself.

DR. HOPENFELD: What page?

JUDGE WARDWELL: I've got to find it now. I've got the wrong reference. Dr. Hopenfeld, do you know where your JH-63, where I would find JH-63 again?

DR. HOPENFELD: Well, maybe Marcia -

JUDGE WARDWELL: Here it is. I got it. It's attached to the rebuttal, the June 6^{th} rebuttal.

JUDGE KARLIN: We've got it, Marcia.

JUDGE WARDWELL: At page 34.

MR. HOFFMAN: Thirty-four?

JUDGE WARDWELL: Strike that question entirely. I see this has been redacted. It's not crucial.

As a general comment, while I think of it, especially I think for tomorrow so I don't forget tomorrow when we start NEC-4, I'm sure Entergy is aware of that, but if we start getting into proprietary questions accidentally, I'm sure you will notify us. Good. Thank you very much. We would appreciate the help with that, because we're liable to get excited, and get on a roll, and not realize where we are.

Dr. Hopenfeld, besides stress levels on the steam dryer, are there any other parameters that you think should be added to the monitoring program that would practically, and -

DR. HOPENFELD: The steam lines.

JUDGE WARDWELL: That would be of practical use, and significantly improve the aging management of that -

DR. HOPENFELD: I don't think so.

JUDGE WARDWELL: Thank you. Continuing on with NEC JH-63, page 24, either Mr. Hoffman or Mr. Lukens, whoever feels interested in responding to this, Dr. Hopenfeld presents a quote from the PNL, Pacific Northwest National Labs that says under Answer 36 on that page, "Unlike the previously discussed mechanism (corrosion) vibration fatigue does not lend itself to periodic in-service examinations, volumetric, surface, et cetera, as a means of managing this degradation mechanism." And he goes on to then quote, "Once a crack initiates, failure quickly follows."

What's your reaction to that statement by the National Lab in regards to -

MR. LUKENS: Your Honor, I would like to put that statement in the context of the document from which it was quoted.

JUDGE WARDWELL: Please do.

MR. LUKENS: The title of the document is

"Life prediction and monitoring of nuclear power plant components for service-related degradation", and it discusses at some length the methods used by the nuclear industry to address aging effects in power plant components.

The quote that Dr. Hopenfeld provided in his exhibit, page 62 of the document from which it comes, it is page 4 of the exhibit.

JUDGE KARLIN: Which exhibit number are we talking about now? I mean, for the record, I'm lost.

MR. LUKENS: This is NEC JH-69.

JUDGE KARLIN: Okay. Thank you. I'm sorry.

MR. LUKENS: In the first-hand column about halfway down there's a paragraph entitled, "High cycle mechanical vibration fatigue." And it states, and I quote, "More and more attention has recently been paid by operating plants to prevent unexpected piping failures due to high cycle vibration fatigue. Small bore pipe, less than one inch nominal pipe size, socket welded vent and drain connections in the immediate proximity of vibration sources tend to be most susceptible to this failure mechanism." The next sentence is the one Dr. Hopenfeld quoted, so this paragraph is talking about socket welded vent and drain connections less than one inch in power plants. This statement has nothing to do with steam dryer in boiling water reactors.

JUDGE WARDWELL: Dr. Hopenfeld, how do you extrapolate this particular statement to a steam dryer and boiling water reactor at Vermont Yankee?

DR. HOPENFELD: I don't think this statement used strictly for that very specific welding of piece of equipment. Looking at physically, it was stated before, they want you to get a fatigue drawing with those very facts, and to draw in between the time that you have inspected. It's not restricted to that particular thing. There's nowhere there it's -- this was an example. Even forgetting about that, just going to the mechanism of particular observation, and I think in the context, if you really want to say, I think there's somewhere in that paper where PNL says well, you can spend most of your life in indication of fatigue, you can spend most of your life in initiation process, but once it gets started, it goes. So I don't think that's really restricted to that. It was written in that context, but -- I mean, that paragraph, that's not restricted -

JUDGE WARDWELL: I don't have the reference in front of me, and rather than take the time to get it, maybe you can lead to this. I know there's testimony in it, but this is directed to, I think, Mr. Hoffman, would be the best, if my recollection is correct, to describe, if you could, the qualifications of the individuals that will be assessing the results of the parameters that you are monitoring for, and the qualifications of the people that are making decisions to verify that, in fact, you are having qualified people in that management program that is driving it.

MR. HOFFMAN: As I stated earlier, just for a basis, if the off and on procedure requires an engineering evaluation, it gets sent to the engineering organizations. All of the engineers at Entergy, in order to perform independent work, need to be qualified to do that work. And they're qualified through a prescribed Institute of Nuclear Power Operations INPO Engineering Support Personnel ESP Training Program that prescribes the training methodology, the kind of training they need, the experience they need before they can work independently. In addition to having that training, they need to have their supervisor sign off that they have properly completed the training, and that they have performed the work under the guidance of someone else, and the supervisor is satisfied with the level of the work that's performed.

We also have, as part of our training program, an annual -- as a minimum, an annual assessment by the engineer and his supervisor. If either one of them feel that there particular job responsibility require additional training or if something has developed in the industry where they feel they need this training to do their job properly, it's put into the training program. It's part of their performance evaluation to get that training, and have that training executed. The training program itself is, I believe it's a triennial basis, but INPO comes in and audits our training program. And it's very extensive, having been through it, a very thorough detailed assessment of the quality of the training program to insure that personnel are qualified to do their job.

The industry, in general, Entergy, in particular, takes it very seriously that unqualified personnel do not perform safety-related work. People need to meet the qualifications to do the work.

JUDGE WARDWELL: From the NRC staff, Mr. Rowley, or Hsu, or Scarbrough, whoever feels in the best position to answer this, have you reviewed their qualification program, and determined that, in fact, yes, it does meet your - I think at one point you use the phrase "the need for a qualified structural engineer, for instance, to assess some of this information, if my memory is correct. But are you satisfied that that training program is going to meet the level of expertise needed to evaluate the data associated with this aging management program?

MR. HSU: Yes.

JUDGE WARDWELL: Would you speak a little louder?

MR. HSU: Yes.

JUDGE WARDWELL: You have reviewed it, and you have determined that it does meet your -

MR. HSU: It's not a review. Okay. Because this thing is part of the aging management program audit, and I remember the first time that qualification issue come out is when we're doing the Entergy's so we know there's a program, they do have the qualification. We asked if they're doing the inspection, and then what is it their personnel qualification. They do have program. I think in the -- that what's there. Now for this specific plan, we did not probably specifically look at that. According to our experience with Entergy, we do know they do have this program. They do have the personnel qualification program.

JUDGE WARDWELL: And why did you not look at it for this specific program? Is that what you just said, that you did not look at it specifically for Vermont Yankee?

MR. HSU: Yes, because that's probably the -- because all activity be limited when we go to the audit. We only have probably around eight days, so all this program is going to be audited by the last year's resident inspector, and they are going to implement all this site activity.

JUDGE WARDWELL: Okay. Thank you.

MR. ROWLEY: Yes, that's something we don't look at directly in license renewal. That's not part of what we do, but NRC, other aspects of NRC looks at that, but not license renewal.

JUDGE WARDWELL: And is that because you believe it's part of ongoing operations, and is a continuation of that through the renewal period that you don't? Why wouldn't you, specifically as relating to the aging management plan, you have to evaluate the adequacy of that in regards to demonstrating that it can achieve the results of Part 54.

MR. ROWLEY: These inspections are

something they have to do now, not wait until they get to license renewal, so that's a current operating thing. By the time we get to license renewal, it's already set, and we don't look at it.

JUDGE WARDWELL: Okay.

JUDGE KARLIN: I have one -

JUDGE WARDWELL: I did not mean to tell a lie. I've got one more, then I want to add a note to get back to something. This was something you mentioned, Dr. Hsu, and it was a conversation between Mr. Scarbrough - not a conversation, it was an iterative stepping that we went through between Mr. Scarbrough, who reviewed lots of this information in regards to the steam dryer associated with the power uprate, and then Mr. Hsu, who's reviewed it, as I understand it, for the extended period of operation. And it dealt with our discussions of the design-basis accident, and the need to demonstrate that the steam dryer can maintain its integrity during that. And you said, Mr. Scarbrough, I believe, that you did review it for the power uprate and found it to be adequate in regards to Entergy's review of that effort. Is that correct?

MR. SCARBROUGH: The NRC staff team did, as indicated in the safety evaluation for that power plant.

JUDGE WARDWELL: And you're familiar with it, and you stand by that in representing the staff.

MR. SCARBROUGH: Yes, sir.

JUDGE WARDWELL: And, Mr. Hsu, you mentioned that you did not do that as a license renewal.

MR. HSU: Yes, we did not do. The aging management program is look at it from the inspection and the monitoring point of view. But inspection point of view, we try to detect something, so if anything happen between the inspection period, the monitoring program is going to tell you what's going to happen, so that's supplemental that your inspection activity. So we concentrate in this area.

JUDGE WARDWELL: And the reason that you didn't -- part of the reason that you didn't look at the integrity of the steam dryer in regards to a design-basis accident is, again, back to the fact that it's an operational issue that has been reviewed by Mr. Scarbrough, and that same analysis will take place, as long as the steam dryer maintains its integrity, and you've got a monitoring program, a management program, I should say, for aging, which you feel is satisfactory to help assure that that steam dryer maintains its integrity.

MR. HSU: Yes.

JUDGE WARDWELL: I think I understand that now. Thank you. Now I'm done.

JUDGE KARLIN: Okay. I think I need to ask, or clarify and understand one final point, and then we'll probably be done, and take a break. Because I think I'm over-simplified, or my understanding was over-simplified with regard to the dichotomy between whether the monitoring program is there for a prediction purpose, or for detection purpose. And it's apparently not quite as simple as that.

Can I direct Mr. Hoffman to the testimony that you gave on your pre-filed exhibit at page 28, Question 53, Answer 53. And probably when I'm done, and this hopefully won't take too long, then I will ask Mr. Hsu and Mr. Rowley, perhaps, their thoughts on this. And this is the prediction/detection question I was over-simplifying before, I think.

Question - "Dr. Hopenfeld states that moisture monitoring only indicates that a failure has occurred. It does not prevent the failure from occurring." And you're asked a question about that, and you state, and this sentence is one I need to focus on. "Monitoring of plant parameters will not predict the incipient formation of cracks, but it will identify the existence of cracks sufficiently large to adversely affect dryer performance, and flag the risk of structural failure of the dryer."

So, as I understand it, everyone is in agreement that monitoring of the plant parameters isn't going to predict the cracks. Mr. Hoffman?

MR. HOFFMAN: Yes, sir.

JUDGE KARLIN: But it will detect cracks. Is that what you're saying here? "Identify the existence of a crack sufficiently large to adversely affect dryer performance."

MR. HOFFMAN: If one was developing sufficiently large, you might be -- you would detect it through the monitoring, the online monitoring program.

JUDGE KARLIN: You might, you would?

MR. HOFFMAN: No, if it was sufficiently large -

JUDGE KARLIN: Sufficiently large, you would. "Sufficiently" is the operative word.

MR. HOFFMAN: That's correct.

JUDGE KARLIN: Okay. And then it says -- and so what good is that, detecting the --

"sufficiently large to adversely affect dryer performance." And then the next phrase, "And flag the risk of structural failure of the dryer. Flag the risk." So is it predicting, is that a predictive function then? When you say "flag the risk", you mean it's telling us what's going to happen in the future, giving us an indication.

MR. HOFFMAN: Not predictive in the sense of say predictive maintenance. What I was trying to say there was that -

JUDGE KARLIN: It's giving us an early warning as you say at the bottom of this page.

MR. HOFFMAN: It's indicative of something is changing in the dryer to affect its performance, and based on our monitoring to date, and we're talking right now, even though we are executing the same program -

JUDGE KARLIN: No, no, no. I don't want the monitoring to date, I want the monitoring of plant parameters. You're saying that it will detect cracks sufficiently large that will predict the risk of structural failure.

MR. HOFFMAN: Yes. What I'm saying is that this program which goes into place following 2012, will have built on the operating experience that we're seeing now between 2006 and 2012, the EPU conditions, demonstrations to-date by the inspections, and what we certainly anticipate and expect by the future inspections between now and 2012, we'll see that we don't have a high cycle fatigue phenomena going on on the dryer, so anything is developing, it's very slowly developing. It will give us time to, if we see these parameters starting to change, it's not going to be this very rapid propagation for failure, because we don't have that mechanism. And, therefore, it would give us time to respond, to shut the plant down. It's not a case of -- you wouldn't see the moisture go up today and tomorrow have the dryer fail. That's what I was trying to say, so it's not going to predict the failure, but it says something is going on. You need to take a look at it. And the length of time for it to develop beyond where it is is sufficiently long that our procedure would enable us to perform those evaluations and shut the plant down, if necessary.

JUDGE KARLIN: Okay. Then the first sentence, "And flag the risk of structural failure of the dryer." What do you mean by "structural failure"? Let me ask this more specifically. Would the breaking off of a chunk, say six by six inches, qualify as structural failure of the dryer?

MR. HOFFMAN: In my terminology for here, the dryer is intended to be nominally a cylinder all in tact, and a structural failure would be a loss of that in-tactness, so to speak, of the dryer. It could be a piece coming out, it could be -

JUDGE KARLIN: All right. So if a six inch piece comes off the dryer, is that a structural failure of the dryer?

MR. HOFFMAN: In this terminology, yes. I'm sorry.

JUDGE KARLIN: We're not talking about a total collapse of the dryer or something.

MR. HOFFMAN: No. The piece is no longer the same piece it was before it started.

JUDGE KARLIN: Okay. I think that's probably good enough. I don't need to ask the staff on this one. Thank you.

I think we are going to take a break at this point and review our notes to see if there's any questions we think we have missed, or maybe need to follow-up on. This is where we have the time when parties will have the opportunity to give us suggestions as to questions that they think we've missed, or would counsel that we ask, and so we'll do the same procedure as we did before.

It is now -- let me ask, do the parties think that they have some questions that may be wanting to ask us to propound?

MR. RAUBVOGEL: Yes.

JUDGE KARLIN: All right.

MS. BATY: Possibly.

JUDGE KARLIN: Possibly. All right. Why don't we take a -- Entergy?

MR. LEWIS: No.

JUDGE KARLIN: No, you probably don't. All right. Well, I'm not holding you to it, but okay, just an indication. That's good enough to tell me. Why don't we take a 15-minute break, and reconvene at 10 after the hour. And at that time, you can submit -- well, are you going to submit them to us in writing?

MR. RAUBVOGEL: We were planning to.

JUDGE KARLIN: NRC staff? And during the 15 minutes, or how much time do you need?

MR. RAUBVOGEL: We need 10 minutes or so, and then we can give them to you typewritten and ready.

JUDGE KARLIN: All right. Well, maybe we ought to extend the break a little bit longer so we can read them and digest them, as we did before. Vermont, do you all have anything, Ms. Hofmann?

MS. HOFMANN: We actually gave them to NEC.

JUDGE KARLIN: Oh, that's right. That's what you all did yesterday. And, Mr. Roth, do you think you have anything?

MR. ROTH: Yes, I have a few.

JUDGE KARLIN: Okay. Well, why don't we make it 20 minutes, during which time if you have written questions, and you can get them to us during the 20 minutes, please get them to the law clerks, and we'll try to look at them, and reconvene. Three copies, if possible. Yes, sir?

MR. TRAVIESO-DIAZ: Are we going to get to Contention Four today?

JUDGE KARLIN: It somewhat depends -- we may very well get to some of Contention Four. It depends on what kind of questions we get, or what we think we may need to ask. I think it's a pretty good bet that we'll at least -- I think our theory would be we at least want to swear the witnesses in, and get the exhibits out on the table, and get that procedure done today, if nothing more than that, so we could hit it fresh in the morning. Okay? So we'll take a 20-minute adjournment.

(Whereupon, the proceedings went off the record at 2:58 p.m., and went back on the record at 3:32 p.m.)

JUDGE KARLIN: On the record. We're now back in session. I would like to go back on the record and remind the witnesses you're still under oath.

We've received some questions from several of the parties. May I ask? Are there any of the parties that want to offer questions orally at this time?

(No verbal response.)

Okay. So we'll just deal with the ones that were submitted in writing. And as we proceed, I think I'll just give you anticipation of our hope for the reminder of the afternoon. It's about 3:30 p.m. right now. We will go through these questions hopefully relatively crisply and then thank the witnesses on Contention 3 and our thought is to make as much progress as we can on Contention 4 today as well and the thought being we would ask for the Contention 4 witnesses to be brought forward, to be sworn in and ask the counsel to introduce the associated exhibits for each of them and then also to have the presentation by Dr. Horowitz, his 12 slides or whatever it is that we asked for and I think that will take us up to 5:00 p.m. and we'll be done for the day and then we can start crisply in the morning tomorrow and may be able to finish tomorrow. That's the idea.

Dr. Horowitz is available to do that?

(No verbal response.)

Great. Okay. So any other questions or points at this time?

(No verbal response.)

All right. Then we have some follow-up questions for the panel. (Aside.) Do you want to go first? Okay. Let me ask a question.

JUDGE REED: If you're not ready, I'll go.

JUDGE KARLIN: No, I think I'm ready. This is for -- Again, I'm not sure who it's for, but I'm going to ask it of two parties, one NRC Staff, Mr. Scarbrough and Mr. Hsu, Mr. Rowley, whatever. If you believe that there were a higher chance of a crack occurring in the steam dryer than you currently believe, would you have a different monitoring or inspection program? If, for example, you were not sure about the -- Well, would you change anything? Mr. Scarbrough.

MR. SCARBROUGH: Yes. The information I was provided by the Licensee as part of power uprate with the review of the Staff and its consultants reached their assurance findings that the stresses were below the fatigue limits and part of the conditions of that were to evaluate the uncertainties and we were comfortable with that. However, because of the past occurrence at Quad Cities, we wanted to be doubly sure that we had a very robust monitoring and inspection program and that's what you see in the license conditions that were imposed. I mean, there was a very slow and deliberate power ascension that took place and I was a member of that team that monitored it as it went up.

JUDGE KARLIN: Let me cut through it. The power ascension program with regard to the EPU, it's occurred. You all are having some reliance upon the confidence that is gained from that. If you were not so confident about the iVibration (phonetic), you know, that program, would you change anything about the ongoing monitoring program?

MR. SCARBROUGH: And the answer to that is if we weren't confident in the evaluation we would not have granted the power uprate.

JUDGE KARLIN: I'm positing something which is different which is if you weren't that confident would you have done something different.

MR. SCARBROUGH: Yes. I would imagine if there was some additional areas that we might have decided that we had needed for a series of inspections during outage, I mean, we could have done something like that. We could have added another one, I guess. If there was some sort of small amount of additional uncertainty, you might have added another inspection in terms of series of outage. We might have.

But in terms of what was done, in terms of having a repetitive inspection process, where you did a full inspection based on the GE SIL documents 644.

JUDGE KARLIN: Okay. I think you answered the question.

Another question for the Staff, I'll focus on Mr. Scarbrough I guess. We talked about the GE Sil 644.

MR. SCARBROUGH: Yes.

JUDGE KARLIN: Is a part of Vermont Yankee's current licensing basis only via the steam dryer monitoring plan Revision 3?

MR. SCARBROUGH: It's part -- It was part of the license conditions for the EPU and the license amendment that was granted in March of 2006.

JUDGE KARLIN: And that was the steam dryer monitoring plan, was it not?

MR. SCARBROUGH: Right.

JUDGE KARLIN: So is that the only way that SIL 644 gets into the current licensing basis as part of the steam dryer monitoring plan that was imposed on the EPU?

MR. SCARBROUGH: I would assume so. I'm not familiar with all the other possible --

JUDGE KARLIN: Maybe I'll ask Mr. Hsu. Is there any -- Are you aware of any other way that that SIL 644 gets into the current licensing basis?

MR. HSU: I'm not aware of it. I think that's the correct way.

JUDGE KARLIN: All right. Mr. Rowley.

MR. ROWLEY: It is -- If there's any other way, I'm not sure. But the current license does specifically state that 644 --

JUDGE KARLIN: Right. Mr. Lukens, perhaps you know or could answer that question please.

MR. LUKENS: I'm only aware of the connection between 644 and our current licensing basis through the license condition that currently exists as a --

JUDGE KARLIN: All right. Thank you. I have a couple more here. This is a question for Mr. Scarbrough or whoever else on the Staff feels it's --

We talked about the BWR VIP-139 Program and you talked about it might be approved by NRC sometime this year, Mr. Scarbrough.

MR. SCARBROUGH: Yes.

JUDGE KARLIN: Okay. And let's say that it is approved by the NRC and Vermont Yankee says it's unacceptable and they take exception to some part of it. Will there be an opportunity for public participation when that event occurs?

MR. SCARBROUGH: At's part of the license condition power uprate, it does specify that the steam dryer monitoring plan incorporates the SIL 644 Revision 1. So that's part of their steam dryer monitoring plan. If they decided not to follow the VIP-139 or they were making changes, I would imagine what might happen would be a public meeting between the NRC Staff and the Licensee to discuss what their proposal.

Because typically what we do when we have for the steam dryer issue, we'll have public meetings with the licensees and they'll describe what they plan to do. So that's where there would be some public participation in that.

JUDGE KARLIN: So the scenario is NRC approves 139 and Entergy takes exception to 139 and the opportunity for public input as to whether that exemption should be granted is what, if anything?

MR. SCARBROUGH: I don't believe there is any direct input in terms of a comment period of things of that nature unless there was --

JUDGE KARLIN: So there is no opportunity for public input or comment on whether the exemptions should be granted.

MR. SCARBROUGH: Other than to a public meeting where there might be public risk involved.

JUDGE KARLIN: Is there a public meeting where the Staff and the Applicant have a talk?

MR. SCARBROUGH: Yes.

JUDGE KARLIN: And does Public get to ask questions?

MR. SCARBROUGH: At the end, typically they'll be allowed to raise questions.

JUDGE KARLIN: Will there be an opportunity for -- Will a notice for opportunity for hearing be issued on whether or not that exemption should be granted?

MR. SCARBROUGH: I'm not aware of any.

JUDGE KARLIN: And you think not?

MR. SCARBROUGH: I think not.

MS. BATY: They said there wouldn't be an exemption because it's not a regulation. It would be -- Depending on what they're doing, it could be license amendments.

JUDGE KARLIN: All right. Thank you.

MS. BATY: But it wouldn't technically be an exemption.

JUDGE KARLIN: Okay. The terminology.

MS. BATY: The terminology just to be clear on that.

JUDGE KARLIN: Would this be an exemption under 50.13?

MS. UTTAL: No. An exemption would be from the regulations. So if they were seeking -- on regulations, then 50 would be appropriate.

JUDGE KARLIN: Thank you. So I think the terminology was used that they take exception to it. So thank you. That's helpful. But the bottom line is whatever the event is there will be no opportunity for, no notice of opportunity, to request a hearing on that by the public.

MR. SCARBROUGH: As far as I know, that's correct.

JUDGE KARLIN: Will the Staff determination on whether or not to grant Entergy an exception from 139 be appealable to the Commission by the public, a member of the public?

MR. SCARBROUGH: I don't know really the normal process. I mean, there are requests in some areas and things of that nature. I guess it goes to that process because I'm not --

JUDGE KARLIN: All right. Thank you.

JUDGE REED: Okay. I've tried to organize these a little bit, but there are questions that are kind of scattered. I'll start with this one.

I guess this would be addressed probably to Mr. Lukens. After the 2003 BWR 3 event, and I presume that's the Quad Cities event.

MR. LUKENS: Yes sir.

JUDGE REED: A number of corrective actions were taken to fortify the steam dryer. How did Vermont Yankee perform similar corrective actions?

MR. LUKENS: I have as an exhibit the RAI that was submitted as part of our license renewal process. Okay. I've nearly misspoke. It's an RAI that came from an EPU application and what it contains in part is a table that showed the modifications we proposed to do initially and then the modifications we did ultimately. And this is Exhibit --

JUDGE REED: Could you simply summarize the results of that examination?

MR. LUKENS: The results are that we either did what we said we would do earlier or we did more than that.

JUDGE REED: Okay. But can you tell us what actions were taken?

MR. LUKENS: We replaced the vertical sections of hood, the reinforcing vessels in that vertical section. We replaced end plates. We replaced high bars.

JUDGE REED: And when you replaced them did you replace them with an identical component of new or were they -- in some way?

MR. LUKENS: No, they were not identical. All of them were made more robust. For example, in the vertical hood, we replaced one quarter inch material to 5/8ths and we replaced, if I may, little bitty reinforcing gussets with full lengthwise. That was part of the experience that came out of the 2003 event. They had clipped these gussets in the Quad Cities' dryer, but they weren't full length and it turned out that a couple of gussets became in stress range. So informed by that information, we changed them out.

JUDGE REED: Now does this run from bottom to top or are we talking -- I'm not sure.

MR. LUKENS: They run from the bottom of the vertical hood to the top of vertical hood.

JUDGE REED: The top of the vertical hood.

MR. LUKENS: They're on the order of four feet high.

JUDGE REED: Thank you.

MR. LEWIS: Judge Reed, do you want to witness to identify the location of this. It is an exhibit.

JUDGE REED: It is an exhibit?

MR. LUKENS: Yes sir.

MR. LEWIS: Yes.

JUDGE REED: Yes, if it's an exhibit, please.

MR. LUKENS: It's Exhibit E3-04-VY.

JUDGE REED: Thank you.

MR. LUKENS: Its title is "Attachment 2 to Vermont Yankee Nuclear Power Station Proposed Tech Spec Change NO. 263, Extended Power Uprate Supplement No. 8, Response to Request for Additional Information." And given a few minutes, I can tell what page that's on.

JUDGE REED: I think that's okay. I think we can locate it with what you've given us. We're not going to take the time to look it up here today.

Any other changes that were made?

MR. LUKENS: The table in this exhibit captures all the modifications that were made for the Vermont Yankee steam dryer.

JUDGE REED: Okay. If it's in the record, we will look it up.

MR. LUKENS: Right.

JUDGE REED: Thank you for identifying that.

So this is a -- I think you've answered this question, but I'm going to ask it just to make sure. What modifications did you make to steam dryer prior to EPU and I think this is --

MR. LUKENS: Those 2004 modifications were the EPU-related modifications.

JUDGE REED: Okay.

JUDGE REED: Another question again for you, Mr. Lukens. Can Entergy inspect the dryer whenever the plant shuts down such as a parameter accedence shutdown? So if the plant shuts down for whatever reason, can you inspect the dryer?

MR. LUKENS: Typically, on a shutdown that occurs on some simple event, and parameter accedence is an example of one of those, we never enter primary containment. We never take a head off of a reactor vessels. So the answer to that would be no. It would not be practical.

JUDGE REED: So in order to inspect, you have to take the head off the vessel.

MR. LUKENS: We have to take the head off. We have to take the dryer out.

JUDGE REED: So it would not be practical to do inspections on other than refueling cycles.

MR. LUKENS: That's correct.

JUDGE REED: I think that's the gist of this question. Okay.

Now I have several questions that relate to IGSCC. I'm not sure I have them in any particular order. Can IGSCC cracking eventually result in sudden breaking apart of steam dryer components? Again, for you, Mr. Lukens.

MR. LUKENS: The real answer to that is no. For an IGSCC crack to become a site for fatigue, it has to be in a location where there is a cyclic stress above the endurance limit and the location we have identified IGSCC cracks are not in high stress areas of the dryer. We have not found any indications in the high stress areas of the dryer.

JUDGE REED: Thank you. In 2007 inspection that you spoke of, were there cracks that could not be immediately classified as IGSCC and took further evaluation?

MR. LUKENS: Yes.

JUDGE REED: If so, what was the nature of that further evaluation?

MR. LUKENS: There were -- I can think of two different sets of indication that took us a day or two to evaluate and this was not done simply by Vermont Yankee. These indications because they're captured on CD by a camera, that information, the real time inspection data, was transmitted to structural engineers at General Electric. These are the folks who know as much about a steam dryer as anybody knows and we worked with them to characterize those indications.

JUDGE REED: And the results came back.

MR. LUKENS: And the results came back IGSCC.

JUDGE REED: IGSCC. Thank you.

And I have one last question and again I think it's for you. Isn't Vermont Yankee switching from an 18-month to a 24-month interval between refueling outages and therefore inspections of the dryer?

MR. LUKENS: I am 90 percent confident

that we are not. It's been investigated and my current understanding is that it is somewhere between unlikely and not possible that the current configuration in the reactor vessel with the number of control rods we have, the size core we have, that we could control a 24-month cool.

JUDGE REED: Okay.

JUDGE KARLIN: Is there some intermediate extension or is it 18 months into the future?

MR. LUKENS: I'm not aware of --

JUDGE KARLIN: We go to 20 months.

MR. LUKENS: -- intervals except 18 and 24.

JUDGE KARLIN: Okay.

JUDGE REED: That's all I have.

(Off the record discussion.)

JUDGE KARLIN: I think we have completed our inquiries and questions related to Contention 3. Again, our appreciation to the witnesses who spent a lot of time preparing, submitting materials and then being patient with answering our questions here, especially mine here being the least technical of everyone in this room probably.

But, anyway, thank you and you all may step down now. We don't need you anymore. You may be dismissed and thank you for your testimony.

What I'd like to do is ask the parties to -- Yes, Mr. Raubvogel.

MR. RAUBVOGEL: We would request that questions that we submitted both yesterday and today and any others be part of the record in the same manner that our direct examination plan was submitted to the Board just so that it's a part of the entire record.

JUDGE KARLIN: I think that would be -- Any reaction from the other parties? Staff? Yes, I think that's -- Sir?

MR. TRAVIESO-DIAZ: I believe that was what was done in other nuclear proceedings. It was put on the record at the end.

JUDGE KARLIN: Yes, I think that's right and that's the appropriate thing to do. So what -- We have handwritten questions from some of you and actually we only have one copy of some of these handwritten questions and I did want to remark that whoever did these gets an A for penmanship.

(Laughter.)

MR. RAUBVOGEL: Would you like to provide additional copies to the clerk?

JUDGE KARLIN: Yes. I don't know how we

can get an additional copy of this. Mr. Roth, for example, this is your only copy. Right?

MR. ROTH: That's correct.

JUDGE KARLIN: So I think we'll just have to put these in the record after the record closes. I think that's the appropriate time. We'll follow the same procedure under the Reg. about putting these questions in with one exception, Mr. Raubvogel. We're not going to ask SECY to put it on the electronic hearing docket then until we're sure.

With that, you are all dismissed. Thank you.

(Panel of witnesses excused.)

And if we could get the witnesses for Contention 4 up, we will have them sworn and introduce their exhibits and then proceed to Dr. Horowitz's presentation. Off the record.

(Whereupon, at 3:55 p.m., the above-entitled matter recessed and reconvened at 3:59 p.m.)

JUDGE KARLIN: All right. Can we go back on the record, Mr. Reporter? Thank you.

The Atomic Safety Licensing Board is now ready to begin consideration or the evidentiary hearing portion of consideration of NEC Contention 4 and I see we have the witnesses sitting in the witness box and so I will ask you all to rise please and raise your right hand. Please stand and raise your right hand.

Whereupon,

CONTENTION 4 PANEL

were called as witnesses and, after having been first duly sworn, were examined and testified as follows:

JUDGE KARLIN: Thank you. Please be seated.

Welcome. Now I will ask counsel for Entergy to interrogate its witness so that we can introduce the exhibits please.

MR. LEWIS: Thank you, Judge Karlin. I'm going to direct these questions to Entergy's witnesses, Mr. Horowitz and Mr. Fitzpatrick.

Gentlemen, do you have before you a document bearing the caption in this proceeding entitled "Testimony of Jeffrey S. Horowitz and James C. Fitzpatrick on NEC Contention 4, Flow Accelerated Corrosion" dated May 12, 2008?

DR. HOROWITZ: Yes.

MR. FITZPATRICK: Yes.

MR. LEWIS: Did you prepare this testimony for this proceeding?

DR. HOROWITZ: Yes.

MR. FITZPATRICK: Yes.

MR. LEWIS: Do you have any corrections to this testimony?

DR. HOROWITZ: Yes.

MR. LEWIS: What are they please?

DR. HOROWITZ: On page 33, answer 49, lines six and eight, I believe the sentence that says "The portion of this statement concerning elbows and by extension other geometries, other than straight pipe is incorrect."

MR. LEWIS: Thank you. For the record, this is a duplicate of the leading-up prior statement. So it's simply repeated or a redundant statement. Copies have been given to the other parties and copies of this corrected testimony has been given to the court reporter.

JUDGE KARLIN: All right.

MR. LEWIS: With this correction, is this testimony your true and accurate testimony in this proceeding?

DR. HOROWITZ: Yes.

MR. FITZPATRICK: Yes, it is.

MR. LEWIS: I would move that this testimony be moved into evidence as is read.

(Whereupon, the document

referred to was marked as Entergy Exhibit E4-01 for identification.)

JUDGE KARLIN: Any objections?

(No verbal response.)

Hearing none, it is admitted into testimony.

(The document referred to having been previously marked for identification as Entergy Exhibit E4-01, was received in evidence.)

CORRECTED

May 12, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
Entergy Nuclear Vermont Yankee, LLC	)	Docket No. 50-271-LR
and Entergy Nuclear Operations, Inc.	)	ASLBP No. 06-849-03-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

JOINT DECLARATION OF JEFFREY S. HOROWITZ AND JAMES C. FITZPATRICK ON NEC CONTENTION 4 – FLOW-ACCELERATED CORROSION

Jeffrey S. Horowitz and James C. Fitzpatrick state as follows under penalty of perjury:

1. We have prepared the attached "Testimony of Jeffrey S. Horowitz and James C. Fitzpatrick on NEC Contention 4 – Flow-Accelerated Corrosion" in the above captioned proceeding.

2. The factual statements and opinions we express in the cited testimony are true and correct to the best of our personal knowledge and belief.

3. We declare under penalty of perjury that the foregoing is true and correct.

Executed on May 12, 2008

/Original signed by Jeffrey S. Horowitz/

Jeffrey S. Horowitz

/Original signed by James C. Fitzpatrick/

James C. Fitzpatrick

Executed on May 12, 2008

Errata to Applicants' Testimony on NEC Contention 4

Witness	Citation (Page/Answer)	Correction
Horowitz	33/A49 (lines 6-8)	Delete sentence "The portion of this statement concerning elbows (and by extension geometries other than straight pipes) is incorrect." [Repeated sentence]

May 12, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
Entergy Nuclear Vermont Yankee, LLC	)	Docket No. 50-271-LR
and Entergy Nuclear Operations, Inc.	)	ASLBP No. 06-849-03-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

TESTIMONY OF JEFFREY S. HOROWITZ AND JAMES C. FITZPATRICK ON NEC CONTENTION 4 – FLOW-ACCELERATED CORROSION

I. WITNESS BACKGROUND

Jeffrey S. Horowitz ("JSH")

Q1. Please state your full name.

A1. (JSH) My name is Jeffrey S. Horowitz.

Q2. By whom are you employed and what is your position?

A2. (JSH) I am an independent consultant.

Q3. Please summarize your educational and professional qualifications.

A3. (JSH) My professional and educational experience is described in the *curriculum vitae* attached to this testimony as Exhibit E4-02. Briefly summarized, I have more than 36 years of experience in the field of nuclear energy and related disciplines. For the last 22 years, I have specialized in flow-accelerated corrosion ("FAC") and nuclear safety analysis. My main client during this time has been the Electric Power

Research Institute ("EPRI"). I have also consulted for utilities that operate nuclear power plants, including Arizona Public Service, Exelon Nuclear, Pacific Gas & Electric, and Southern California Edison. In Canada, I have consulted for the CANDU Owners Group and Ontario Power Generation. I hold four degrees in mechanical engineering. Three of these degrees, including a doctor of science degree, are from the Massachusetts Institute of Technology.

Q4. What is the purpose of your testimony?

A4. (JSH) The purpose of my testimony is to address, on behalf of Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (collectively "Entergy"), Contention 4 submitted by the New England Coalition ("NEC") in this proceeding. As admitted by the Atomic Safety and Licensing Board ("Board"), NEC Contention 4 reads:

> Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of plant piping due to flow-accelerated corrosion during the period of extended operation.

Memorandum and Order (Ruling on Standing, Contentions, Hearing Procedures, State Statutory Claim, and Contention Adoption), LBP-06-20, 64 N.R.C. 131, 192 (2006).

Q5. What is FAC?

A5. (JSH) FAC is a degradation mechanism that attacks carbon steel piping and vessels exposed to moving water or wet steam. It is important to understand that FAC is only one of several mechanisms that can affect the physical integrity of piping and components. The term "FAC" was coined to avoid the ambiguities present in the previously used term – "erosion-corrosion." Specifically, FAC is a corrosion mechanism, not a mechanical damage mechanism (i.e., erosion). Erosive damage also occurs in nuclear piping, but such damage is normally confined to small leaks.

FAC occurs because the protective oxide layer that builds on the surface of carbon steel components dissolves into the flow stream. This attack occurs under specific water chemistry conditions. If FAC is not detected, the piping or vessel walls will become progressively thinner, normally globally (i.e., over a broad area of the component), until the material in the affected area can no longer withstand internal pressure and other applied loads and a rupture (rather than a leak) eventually occurs. It is the global nature of FAC wear that causes a pipe rupture, whereas localized damage due to other mechanisms (e.g., erosion only) causes leaks and does not impact the structural integrity of the piping.

As defined, FAC only attacks carbon steel components in the presence of purified flowing water or wet steam. It does not attack steels containing other fluids, such as oil. Steels containing appreciable amounts of chromium have been found immune to FAC.

Q6. What has been your professional involvement with FAC issues?

A6. (JSH) My involvement with FAC dates back to December 1986, when an elbow in the condensate system at the Surry Unit 2 nuclear plant failed catastrophically. This failure caused steam and hot water to be released into the turbine building, resulting in the deaths of four workers and severe injuries to others. Post-accident investigations revealed that FAC was the cause of the degradation to the elbow. At that time, the U.S. nuclear fleet did not have programs in place to deal with single-phase (i.e., water only) piping degradation caused by FAC. Some programs were in place to deal with two-phase (i.e., water and steam) piping degradation, but in general, these programs were very limited in their scope.

In response to the Surry accident, EPRI became committed to developing a computer program that would assist utilities in determining the most likely places for FAC wear to occur, and thus the key locations to inspect for pipe wall thinning. The late Bindi Chexal, the EPRI Program Manager, gave me the job of designing and implementing such a program. I developed the computer program CHEC (Chexal-Horowitz Erosion Corrosion) and demonstrated and released it to U.S. utilities in 1987. CHEC was replaced by CHECMATE (Chexal-Horowitz Methodology for Analyzing Two-Phase Environments) in 1989. CHECMATE expanded on the capabilities of CHEC by adding algorithms to calculate FAC under two-phase conditions. CHECMATE was the first program to accurately predict two-phase FAC. CHECMATE was later replaced by the current program, CHECWORKS (Chexal-Horowitz Engineering Corrosion Workstation), in 1993. Each new version built on the success of the previous program and incorporated user feedback, improvements in software technology, and available laboratory and plant data into the modeling used in the programs. I remained the technical lead person in the development of these new and revised versions.

Q7. Have you been asked to review the FAC programs for nuclear power plants?

A7. (JSH) Yes. I have performed, by myself or with another engineer, audits of the FAC programs at over fifty nuclear units in the United States and Canada. The most recent FAC program audit I conducted was at VY, in April 2007.

Q8. Have you been involved in the development of industry standards governing FAC programs?

A8. (JSH) Yes. After the first several audits I performed, the need became apparent for a guidance document that would help utilities improve and standardize their FAC programs. NSAC-202L, entitled "Recommendations for an Effective Flow-Accelerated Corrosion Program," was the document created to meet this need. I played a key role in drafting the original version of NSAC-202L and resolving numerous utility and U.S. Nuclear Regulatory Commission ("NRC") comments on it. Since that time, I have played a significant role in each of the three subsequent revisions to NSAC-202L, which has become the most important standard-setting document for the conduct of FAC control programs in the United States. NSAC-202L also has been accepted as a valuable guidance tool by the Institute of Nuclear Power Operations ("INPO") and the NRC.

Q9. Have you written books or technical papers on FAC?

A9. (JSH) After developing CHECWORKS, I co-authored three books on FAC and related issues. One book is a compendium of FAC science and experience; it is the most complete reference available on the subject of FAC. The other two books deal with thermal-hydraulic issues. I have also authored or co-authored more than 30 EPRI reports related to FAC and nuclear safety issues. I was the principal investigator and sole author of 16 of them. Among the most important reports with which I have been involved are a study of weld attack in nuclear piping and preliminary guidance for the protection of piping against damage from erosive forms of attack.

I have also written a number of technical papers on FAC, including papers presented at the International Conference on FAC, "FAC2008" held in Lyons, France in March 2008, at "Water Chemistry of Nuclear Reactors - Chimie 2002" held in Avignon, France (a meeting attended by over 300 international scientists and engineers), at ASME Pressure Vessel and Piping Conferences, at a Nuclear Regulatory Commission Water Reactor Safety Meeting, and at other technical meetings.

Q10. Have you given lectures or technical presentations on FAC?

A10. (JSH) I have made technical presentations at each of the semi-annual CHUG (CHECWORKS Users Group) meetings. CHUG meetings typically attract between 50 and 100 utility engineers and station managers. I have made presentations at every one of the 38 CHUG meetings. My presentations typically cover the results of research I have performed or are technical presentations regarding FAC. In addition to making presentations, I have served as session chair and moderated various discussion groups.

I have also conducted more than two dozen two or three-day training sessions covering FAC and the use of the EPRI computer programs (CHEC, CHECMATE and CHECWORKS). These training sessions have been held in the United States and in foreign countries, including Belgium, Canada, the Czech Republic, Japan, South Korea and Taiwan. The training sessions have been attended by utility engineers, utility managers, engineers from the INPO, and the NRC Staff. I also was an invited participant in the NRC Erosion-Corrosion Workshop in February 1993.

I have developed for EPRI two computer-based training modules. One of these modules covers FAC and the other covers erosive attack on piping in power plants. These modules have been distributed to EPRI member utilities. I also continue to be actively involved in training people to use the latest versions of CHECWORKS.

James C. Fitzpatrick ("JCF")

Q11. Please state your full name.

A11. (JCF) My name is James C. Fitzpatrick.

Q12. By whom are you employed and what is your position?

A12. (JCF) I am employed by AREVA, NP as an Engineering Supervisor. Until March 2008, I was employed at Entergy Nuclear Operations, Inc. ("Entergy") as a Senior Lead Engineer in Design Engineering at VY.

Q13. Please summarize your educational and professional qualifications.

A13. (JCF) My professional and educational experience is described in the *curriculum vitae* attached to this testimony as Exhibit E4-03. Briefly summarized, I have thirty years experience in the design, construction, and modification of nuclear power plant structures, piping systems, pressure vessels, and in the seismic evaluation of mechanical and electrical equipment. Twenty-two of those years are in operating plant engineering support in both the mechanical and structural areas. I have been responsible for the development and implementation of plant design changes, inspection programs, equipment specifications, installation support, outage support, and operability evaluations of degraded components.

Q14. What is the purpose of your testimony?

A14. (JCF) The purpose of my testimony is to address those aspects of NEC Contention 4 that relate to Entergy's activities to address FAC at VY, and particularly the FAC Inspection Program in place at VY, which is to be continued during the period of plant operations after renewal of the VY license.

Q15. What has been your role with respect to FAC control activities at VY?

A15. (JCF) My involvement with FAC dates back to 1987. While employed at Yankee Atomic Electric Company, I assisted in the preparation of VY's response to NRC Bulletin 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," issued as a result of the December 1986 Surry accident. Later, I performed the first modeling of plant piping systems at VY using the EPRI CHEC code to help select the single-phase piping component inspection locations for the 1989 refueling outage.

I was responsible for the development of a long term "Piping Erosion-Corrosion Inspection Program," ("FAC Program") for VY in 1990. Development of this FAC Program involved determining the scope of piping potentially affected by FAC, modeling the plant systems using the CHECMATE code, developing the criteria and procedures for performing the inspections, and evaluating inspection data. I have either provided engineering support or have been responsible for implementing the FAC Program at VY for the thirteen refueling outages from 1989 thorough 2007.

My responsibilities with respect to FAC included reviewing industry experience with FAC and assessing the impact of that experience on the FAC Program at VY. As such, I have developed contacts with other plant FAC Program Engineers by attending many of the EPRI-sponsored CHUG meetings since 1987. I also participated in the NRC Erosion-Corrosion Workshop in February 1993. I have participated either as a team member or a technical specialist in audits and assessments of FAC programs at six other nuclear plants.

Q16. What were your most recent duties with respect to FAC at VY?

A16. (JCF) I was the Cognizant Engineer for the VY FAC Program through June 2007. I was responsible for developing the scope of refueling outage inspections, providing on-site engineering support, screening and evaluating piping and components, determining if the sample of piping locations designated for inspection during a refueling outage needed to be expanded, coordinating piping and component repairs and replacements, updating the CHECWORKS models of plant piping systems, and maintaining the FAC Program Manual and supporting documents.

II. DESCRIPTION OF VY'S PROPOSED FAC PROGRAM

Q17. Would you please describe the program that VY proposes to implement to control FAC during the period following license renewal?

A17. (JCF) As stated in Section B.1.13 of the License Renewal Application for VY ("Application") (Exhibit E4-04), the VY program for addressing FAC is consistent with the program described in the NRC guidance document "Generic Aging Lessons Learned (GALL) Report -- Tabulation of Results," NUREG-1801, Vol. 2, Rev. 1 (Sep. 2005) ("NUREG-1801" or "GALL Report"), Section XI.M17, Flow Accelerated Corrosion (Exhibit E4-05). Exhibit E4-04 at B-47. There are no exceptions in the Application to the guidance in NUREG-1801 with respect to FAC.

The original VY FAC Program was instituted prior to the issuance of EPRI's guidance document NSAC-202L. However, the FAC Program's documents have been revised as necessary over time to conform to the recommendations in the various revisions to NSAC-202L. The FAC Program currently in effect (set forth in Entergy Procedure EN-DC-315, Rev. 0, Exhibit E4-06) substantially follows the current version of NSAC-202L, NSAC-202L-R3 (Exhibit E4-07).

The VY FAC Program includes, as recommended in the GALL Report and the NSAC-202L guidelines, "procedures or administrative controls to assure that the structural integrity of all carbon steel lines containing high-energy fluids (two-phase as well as single-phase) is maintained." Exhibit E4-05 at XI.M-61. A program implemented in accordance with the EPRI guidelines predicts, detects, and monitors FAC in plant piping and other components, such as piping elbows and reducers, as recommended in the GALL Report. Id.

Q18. Can you explain how the FAC Program is used as an aging management tool?

A18. (JCF) The FAC Program includes the following activities: (a) conducting an analysis to determine critical locations; (b) performing baseline inspections to determine the extent of thinning at these locations; and (c) performing follow-up inspections to confirm the predictions, or repairing or replacing components as necessary. Id. NSAC-202L (Exhibit E4-07) provides the general guidelines that are implemented in the FAC Program.

To ensure that all the aging effects caused by FAC are properly managed, NRC guidance recommends that the FAC Program make use of, among other tools, a predictive computer program, such as CHECWORKS, that implements the guidance in NSAC-202L to satisfy the criteria specified in 10 C.F.R. Part 50, Appendix B, "criteria for development of procedures and control of special processes." Exhibit E4-05 at XI.M-61.

Q19. How does the FAC Program proposed for the license renewal period at VY compare to the program currently being implemented?

A19. (JCF) The FAC Program during the license renewal period will be identical to the existing program. The program will conform to the EPRI guidelines contained in NSAC-202L. It will include "procedures or administrative controls to assure that the structural integrity of all carbon steel lines containing high-energy fluids (two-phase as well as single-phase) is maintained." It will also provide detailed instructions on:

- how to conduct the inspections;
- how to evaluate the inspection data;
- the acceptance criteria for inspected components;
- the disposition of components failing to meet acceptance criteria;
- the expansion of the sample to other components similar to those failing to meet acceptance criteria; and
- the updating of CHECWORKS models to incorporate inspection data.

Exhibit E4-06, Section 5.0.

Q20. What inspections are performed under VY's FAC Program?

A20. (JCF) The VY FAC Program conforms to the inspection recommendations contained in NSAC-202L. See Exhibits E4-06, Section 5.0, and E4-07. The FAC Program calls for piping and component inspections to be conducted at each refueling outage, with the items to be inspected being selected based on:

- required re-inspections and recommendations from previous outages.
- CHECWORKS susceptibility rankings or to calibrate the CHECWORKS models.
- industry/ utility/ station experience including items identified through work orders and condition reports.
- the susceptible non-modeled large bore and small bore program piping.
- engineering judgment.

See Exhibit E4-06, Section 5.3.

Q21. Could you explain in more detail how CHECWORKS is used in the FAC Program?

A21. (JCF) The FAC Program at VY primarily uses CHECWORKS' FAC wear rate analysis. VY uses CHECWORKS as a tool in planning inspections, evaluating inspection data, and managing the ultrasonic thickness ("UT") data compiled over the past thirteen refueling outages at Vermont Yankee.

Q22. Are there features of the VY design that result in a reduction of the amount of piping and components at a typical plant that are potentially susceptible to FAC?

A22. (JCF) Yes. Compared to the majority of nuclear power plants in operation, VY is a relatively small and simple plant. There are fewer FAC-susceptible systems and piping components than at a typical plant, and many of those were either originally constructed of FAC-resistant materials or have been replaced with FAC-resistant materials since their initial installation.

VY has vane-type moisture separators with no reheat steam system. This eliminates a large amount of FAC-susceptible piping and a number of components known to be susceptible to FAC found in a typical nuclear power plant.

The extraction steam system piping, which contains a significant portion of the two-phase piping in a power plant, was originally constructed from FAC-resistant materials. A number of other components and associated piping subject to two-phase flow (wet steam) have been replaced with FAC-resistant materials.

The original plant design and the component replacements result in a significantly smaller amount of FAC-susceptible piping at Vermont Yankee as compared to the typical nuclear power plant of similar size.

Q23. Please describe the use of FAC-resistant material at VY.

A23. (JCF) The most effective action in a Boiling Water Reactor ("BWR") to minimize potential FAC effects is to use piping materials that are resistant to FAC. As previously stated, the original design of VY already incorporated FAC-resistant piping for the entire extraction steam system. In addition, since the plant went into operation, carbon steel piping and equipment in a number of systems has been progressively replaced with FAC-resistant materials. These include:

- All 10 of its feedwater heaters.
- Both low pressure turbine casings, including the attached extraction steam nozzles and piping.
- All of the two-phase flow piping in the moisture separator drains system.
- The majority of the two-phase flow piping in the heater drains system except at the lowest pressure feedwater heaters.
- The majority of the turbine cross around piping.
- Small bore steam drain lines to the condenser for the high pressure cooling injection system, the reactor core isolation cooling system, and the advanced off-gas system.
- Small bore shell vent lines for all four of the high pressure feedwater heaters.

Nearly all of the large bore piping at VY which is exposed to two-phase flow was either originally constructed with, or replaced with, FAC-resistant material.

The fluid environments in the remaining FAC susceptible large bore piping systems are either high quality (dry) steam or single-phase flow.

Q24. What other actions have been undertaken at VY to limit the effects of FAC?

A24. (JCF) The addition of the oxygen injection system in 1980 improved the water chemistry with respect to minimizing FAC.

Q25. Can you explain the role of water chemistry at VY with respect to the limiting of FAC?

A25. (JCF) At VY, the addition of oxygen into the condensate/feedwater stream mitigates the effects of FAC on piping exposed to single phase flow.

Oxygen is injected into the condensate and feedwater trains just downstream of the condensate pumps. This results in about 40 parts per billion ("ppb") dissolved oxygen in the condensate and feedwater trains. This level of dissolved oxygen serves to reduce the rate of FAC because, as mentioned previously, FAC is a dissolution process in which the oxide layer on the carbon steel pipe components dissolves into a flowing stream of water or water-steam mixture. By maintaining this concentration of dissolved oxygen in the condensate and feedwater lines, the stability of the oxide film is enhanced and the rate of dissolution is reduced; hence, the potential for corrosion is decreased. This reduction of rates is clearly shown in Section 5.3.2.1, Table 5-2 of Exhibit E4-07.

III. DESCRIPTION OF CHECWORKS

Q26. Can you briefly explain how CHECWORKS works as an analytic tool as part of a FAC Program?

A26. (JSH) CHECWORKS is a multi-purpose computer program designed to assist FAC engineers in identifying potential locations of FAC vulnerability. CHECWORKS is designed to be used by plant engineers as a tool in identifying piping locations susceptible to FAC, predicting FAC wear rates, planning inspections, evaluating inspection data, and managing inspection data.

Q27. Would you please describe in general terms how CHECWORKS calculates expected FAC rates?

A27. (JSH) The rate of FAC is a function of a number of variables that define: (1) the water chemistry; (2) the flow rate; (3) the geometry of the components; (4) the material properties of the components; (5) temperature; and (6) steam quality. Exhibit E4-07, Section 1.1.

CHECWORKS utilizes plant-specific user inputs defining; (1) the oxygen concentration in the feedwater and at the reactor steam effluent (e.g. main steam nozzle); (2) thermodynamic conditions; and (3) flow rates, to calculate the water chemistry at each location in the model. These inputs are applied, together with user-defined component geometry, to an EPRI-proprietary algorithm (the Chexal-Horowitz correlation) to provide an estimate of the rate of FAC for each modeled component.

Q28. How is the CHECWORKS evaluation performed for a particular plant?

A28. (JSH) The modeling of a nuclear unit starts with specification of global data. This process begins with the plant heat balance diagram ("HBD"). The HBD is a schematic representation of the major lines and connectivity of the power producing portion of the nuclear plant. The HBD model constructed in CHECWORKS is then populated with the thermodynamic conditions representative of each power level at which the plant has operated at or is contemplated to operate. The user then inputs the oxygen concentration conditions that have been used or are anticipated. These inputs define the operational history of the plant in terms of what power levels have been used with what water chemistry for how long.

As discussed above, the user also inputs information concerning the piping systems to be analyzed. Most of this information is at the component level and deals with geometry, wall thickness, operating conditions, and pipe material. CHECWORKS includes over fifty geometry models to represent various component geometries. In cases where the component geometry does not match any of the models, the CHECWORKS user is instructed to either use a conservative model or schedule the component for inspection. Likewise, CHECWORKS conservatively assumes that steel components contain the lowest amount of alloying elements allowed by the specification (typically, zero). Such an assumption disregards the beneficial effects of some alloying elements (e.g., chromium) in retarding the onset of FAC.

Based on these user inputs, a "Pass 1 Analysis" is conducted to report predicted wear rates. The results of the Pass 1 Analysis, together with other information including operating experience at similar units, are normally used by the FAC engineer to generate a list of components for inspection.

Once this information is specified in the plant database, the plant engineers are able to conduct wear rate analyses of any or all of the piping defined in the database.

Inspection data may also be input into CHECWORKS. Inspection data may be input in the form of a matrix of thickness readings covering the component. Typically, these data sets are from ultrasonic measurements of the wall thickness at local points (i.e., grid points) or from scanning the component and recording the minimum thickness at grid points. Inspection data are not required for a Pass 1 Analysis.

When inspection data are available, a "Pass 2 Analysis" can be run. A Pass 2 Analysis compares the measured inspection results to the calculated wear rates and adjusts the FAC rate calculations to account for the inspection results. The program does this by comparing the predicted amount of degradation with the measured degradation for each of the inspected components. Using statistical methods, a correction factor is determined which is applied to all components in a given pipe line – whether or not they were inspected.

In addition to refining the Pass 1 Analysis, Pass 2 Analyses provide feedback to the analyst with respect to the goodness of fit of the model to actual results, the location of any outliers, and the possibility of modeling improvements.

Q29. How is the power level history of the plant taken into account in performing the CHECWORKS evaluation?

A29. (JSH) In using CHECWORKS, the engineer breaks the operating time of the plant into a number of periods with a nominally constant power level and reasonably constant water chemistry. For each of these periods, the program calculates a corrosion rate for each component considered in the analysis. The product of the corrosion rate and operating time (i.e., the predicted degree of corrosion) is added up for all the operating periods. Thus, the program predicts the "lifetime" corrosion for each component considered.

Q30. Have the results of CHECWORKS calculations been subject to verification?

A30. (JSH) Yes. The correlations in one of the predecessor programs to CHECWORKS, CHEC, were initially based on FAC laboratory testing data from France and the United Kingdom and a combination of laboratory and plant operational data from Germany.

When CHECMATE was written, and again when CHEC-WORKS was revised in the mid-1990s, a large amount of plant inspection data were used to refine the accuracy of the program's predictions. These data sources included assembled data from a variety of U.S. nuclear units as well as available laboratory data from England, France and Germany (Exhibit E4-08 at 7-20 – 7-33).

CHUG, the users' group associated with the program, has met twice a year since 1989 and has been the major source of feedback on the adequacy of the program. As Mr. Neil Wilmshurst, EPRI's Director of Nuclear Plant Technology, has stated in this proceeding in the "Declaration of Neil Wilmshurst in Support of EPRI's Opposition to Motion to Compel," dated April 18, 2008 (Exhibit E4-09), "[n]uclear [p]ower plants properly using CHECWORKS have never reported a failure in a steam and feed water system pipe or component of 2" in diameter or greater." Exhibit E4-09 at ¶ 11.

Q31. How is CHECWORKS "updated" if there is a change in conditions at a plant using CHECWORKS?

A31. (JSH) The CHECWORKS Pass 2 Analysis is performed with updated user input data that include inspection results, information on material replacements, operating regimes, and changes to operating conditions, such as flow rate or temperature and the water chemistry used. None of the algorithms are modified by plant-specific data. Exhibit E4-09 at ¶ 23.

Q32. How can a user be assured that changes made to the plant's operating parameters remain within the modeling capabilities of CHECWORKS?

A32. (JSH, JCF) This is done in two ways. The range of input variables is defined in the users' manual and checked by the program while the data are being input. Further, there is a data checking feature which ensures that the data are within the allowable range for program operation. At VY, Entergy confirmed that the temperature and flow velocities resulting from the uprate are within the range of the correlations built into CHECWORKS.

Q33. How is CHECWORKS updated for a power uprate?

A33. (JSH) The use of the program does not change on account of a power uprate (or any other change in operating parameters), and remains essentially as outlined above. All that needs to be done is to update plant-specific inputs into the CHECWORKS program. When a power uprate is implemented, a user simply does what he would normally do as part of any Pass 2 Analysis – update the relevant variables (e.g., thermodynamic conditions, temperature, oxygen concentration, etc.), and let the program calculate the predicted FAC wear. The Pass 2 Analysis can be used as a planning tool by performing it in advance of the uprate to determine if, under uprate conditions, systems and sub-systems would experience significantly greater FAC rates than those predicted before the uprate. CHECWORKS was specifically designed to accommodate power uprates and is routinely used throughout the U.S. nuclear industry for this purpose. Exhibit E4-09 at ¶¶ 19, 20. It is important to emphasize that with the implementation of the power uprate at VY the only CHECWORKS inputs which affect wear rates that changed were the flow rate and the temperature.

Q34. Is it necessary to "recalibrate" or "benchmark" CHECWORKS when operating conditions change after a power uprate?

A34. (JSH) No. Power uprates are no different from other operational changes. In fact, the differences in rates experienced in a power uprate are generally smaller than those experienced by units when their water chemistry changes. It has never been necessary to "re-calibrate," "re-baseline" or "benchmark" CHECWORKS when plants have changed their water chemistry, the power output has been increased, or other operational changes have taken place.

IV. ISSUES RAISED IN NEC CONTENTION 4

Q35. Have you had the opportunity to review the testimony of NEC's consultants filed in this proceeding on April 28, 2008?

A35. (JSH, JCF) Yes, we have.

Q36. What testimony did you review?

A36. (JSH, JCF) We reviewed the direct testimony of Joram Hopenfeld, Exhibit NEC-JH_01; Dr. Hopenfeld's report, titled "Review of Entergy License Renewal Application for Vermont Yankee Nuclear Power Station: Program for Management of Flow-Accelerated Corrosion," Exhibit NEC JH_36; Exhibits NEC-JH 37 — NEC-JH_53; the direct testimony of Dr. Rudolf Hausler, Exhibit NEC-RH_01; Dr. Hausler's report, titled "Discussion of the Empirical Modeling of Flow-Induced Localized Corrosion of Steel Under High Shear Stress," Exhibit NEC RH_03; the direct testimony of Ulrich Witte, Exhibit NEC-UW_01; Mr. Witte's report, titled "Evaluation of Vermont Yankee Nuclear Power Station License Extension: Proposed Aging Management Program for

Flow-Accelerated Corrosion," Exhibit NEC UW_03; and Exhibits NEC-UW_04 — NEC-UW_22.

Q37. What are the issues raised by NEC in its testimony with respect to NEC Contention 4?

A37. (JSH, JCF) NEC raises two categories of issues: (1) the alleged insufficiency of the data that will be collected between the implementation of the extended power uprate ("EPU") in March 2006 and the start of extended operations in March 2012 to properly "benchmark" the CHECWORKS program so that it can give accurate FAC wear rate calculations; and (2) whether the implementation of the FAC Program to date has been adequate and will support an adequate FAC management program after license renewal.

Q38. Does NEC challenge any element of the proposed FAC Program as set forth in the License Renewal Application?

A38. (JSH, JCF) No. NEC's concerns are not with the proposed FAC Program (except for the "benchmarking" of CHECWORKS), but with Entergy's ability to properly implement the FAC Program based on NEC's concerns about its past history.

A. ADEQUACY OF DATA COLLECTION

Q39. What is the issue in controversy with respect to the adequacy of the data used to predict FAC effects on VY components?

A39. (JSH, JCF) NEC's consultants claim that CHECWORKS cannot be "calibrated" to model the operating conditions at VY since the EPU before the expiration of the current VY operating license. Dr. Hopenfeld (Exhibit NEC-JH_36 at 25) contends that 10-15 years of data would be needed to calibrate the CHECWORKS model. Dr. Hausler (NEC-RH_01 at 3) claims that it is his opinion "that 12-15 years is a reasonable estimate of the time necessary to calibrate the CHECWORKS model." Mr. Witte (Exhibit NEC-UW_03 at 21) contends that "separate industry guidance supports five to ten years of data trending" for CHECWORKS.

Q40. Do you agree with these assessments?

A40. (JCF) No. As indicated earlier, VY uses five criteria for selecting which components and locations will be inspected for potential FAC effects during a plant refueling outage. Those factors, which are consistent with the guidance in NSAC-202L, are: (1) pipe wall thickness measurements from past outages; (2) predictive evaluations performed using the CHECWORKS computer code; (3) industry experience related to FAC; (4) results from other plant inspection programs; and (5) engineering judgment.

CHECWORKS assists power plant engineers in determining the most likely places for FAC to occur, and thus, the key locations to inspect for pipe wall thinning. However, it is only one of the tools that Entergy will use for that purpose.

With respect to the need to "calibrate" CHECWORKS, Entergy will be able to use the CHECWORKS program effectively to assist in identifying the locations where piping inspections should be performed based on data collected at VY since 1989 and in the three sets of inspections that will be conducted during refueling outages between the implementation of the EPU and the expiration of the current license. Those inspections will yield data for four and a half years of operation at the EPU levels.

Q41. Does the uprate have any effect on the ability of CHECWORKS to be used as an effective tool as part of the VY FAC Program?

A41. (JSH, JCF) No. As discussed above, there is no need to "re-calibrate" CHECWORKS when the operating conditions are due to an uprate change. The new values for flow rate and temperature are simply used as inputs into CHECWORKS and CHECWORKS provides FAC rate calculations for the modeled components under the uprated conditions. Because only the flow rate and temperature are changed due to the power uprate, any FAC rates established after the uprate will be constant and the effect of the uprate on FAC will, therefore, be apparent with the first inspection after the uprate. This first post-uprate inspection, VY-RPT-08-0002, Rev. 0 (Exhibit E4-10) was performed in the Spring of 2007. The results of that inspection demonstrate that data from repeat inspections (before and after the uprate) of large bore components in the feedwater system, which experience continuous flow, show that essentially no wear has occurred since the commencement of the EPU in March, 2006. Exhibit E4-10, Section 8.

As an added measure of conservatism, Entergy will increase the inspection scope by at least 50% for the first three outages following the EPU. In 2005, in RFO 25, the last refueling outage prior to the EPU, there were a total of 35 inspections performed, including 27 large bore inspections. Exhibit E4-38. In 2007, in RFO 26, the first outage since the EPU, the inspection scope was increased by more than 50%, as there were a total of 63 inspections performed, including 49 large bore inspections. Exhibit E4-10. While these additional inspections are not needed to "calibrate" CHECWORKS, they will provide additional, confirmatory data points for the use of the FAC Program.

Q42. Dr. Hopenfeld asserts that, in order to establish the rate of FAC, data are needed from either: (1) inspection of all risk-significant susceptible components "operat[ing] at [a] minimum [of] three inspection periods before a trend can be established," with "[f]ive inspection periods [being] the time interval between component inspection and the establishment of a corrosion rate for a given component at a given location" (NEC-JH_36 at 15); or (2) a "look at historic plant data in terms of the time scale for the occurrence of large, risk-significant wall thinning events," which Dr. Hopenfeld asserts is 16 years. Id. at 16. Do you agree with these assertions?

A42. (JSH, JCF) No. Neither approach is appropriate for determining the rate of FAC through CHECWORKS. During the past 30 years, there has been a great deal of research performed to understand the features and the parametric dependencies of FAC. The approaches suggested by Dr. Hopenfeld, which essentially call for inspection of every potentially susceptible run of piping three times over five inspection periods, discard all analytical work done by the industry and substitute a brute-force unscientific approach. The combination of CHECWORKS and the EPRI guidance have eliminated the need for such an approach.

Dr. Hopenfeld's second approach reduces to the first approach and is equally unworkable. Dr. Hopenfeld appears to assert that in order to determine the rate of FAC, one has to determine how long it takes particular components to fail and gather operating data for every component over that time period, which he claims is 16 years. However, such an approach is also equivalent to not having a FAC Program. Dr. Hopenfeld does not explain how the second approach differs from his first approach other than by taking longer. Presumably, inspections of essentially every potentially susceptible run of piping would be required to assure that excessive FAC wear did not occur.

The operational experience cited by Dr. Hopenfeld does not indicate any problems in the proper use of CHECWORKS as part of a FAC Program nor does it support either of the approaches he proposes. The plants referred to by Dr. Hopenfeld where FAC-related events occurred had no FAC program before the accident (i.e., Surry, Trojan) (see IN 86-106, Exhibit E4-11 and IN 87-36, Exhibit E4-12), or their FAC program was not applied to the component that experienced a FAC-induced failure (i.e., San Onofre) (see NEC-JH_46) or had a FAC program that did not follow the guidance in NSAC-202L (i.e., Clinton, Fort Calhoun and Mihama) (see, e.g., NEC-JH_51 at 1-2; NEC-JH_53, Section 6). Moreover, the logic of Dr. Hopenfeld's assertions regarding his belief that 16 years of operational data are needed is belied by units that have had failures with fewer than 16 years of operation. Dr. Hopenfeld provides no basis for excluding these from consideration as historic plant data. For example, just considering some of the events referenced by Dr. Hopenfeld, the Millstone Unit 3 failure occurred after approximately 4 years of operation, the Sequoyah J-tube experience occurred after approximately 6 years of operation, and the feedring failure at San Onofre Unit 3 occurred after approximately 6 years of operation. Dr. Hopenfeld does not consider these historic plant data or explain why they should not be considered in evaluating the validity of his proposed approaches.

Q43. Mr. Witte states that "[s]eparate industry guidance supports five to ten years of data trending. Trending to the high end of the range is appropriate where variables affecting wear rate, such as flow velocity, have significantly changed, as at

VYNPS following the 120% power up-rate." NEC-UC_03 at 22. Do you agree with this assertion?

A43. (JCF) No. The statement Mr. Witte quotes is taken out of context. The document to which Mr. Witte refers, "Aging Management and Life Extension in the U.S. Nuclear Power Industry," published by the Chockie Group International, Inc., is not "industry guidance." It is a report produced at the behest of the Petroleum Safety Authority of Norway. NEC-UW_13 at iii. The section from which Mr. Witte quotes involves a description of the EPRI Preventive Maintenance Basis Program and describes the use of historical data to assess the performance and reliability of plant equipment, generically, by reviewing 5 to 10 years of the most recent operating history, typically from the plant's work order database. This generic procedure applies to starting a condition assessment program where no aging management program has been in place previously. The reference is simply not applicable to an established program and has nothing to do with CHECWORKS. Nor would it apply to VY, which has had a formal aging management program for FAC in place since 1990. At the end of the current license, the program will have been in place for over 21 years, with at least 20 years of piping inspection data having been accumulated.

Q44. Dr. Hopenfeld (NEC-JH_36 at 15) asserts that one of the reasons a 10-15 year period of data collection is needed to benchmark CHECWORKS for use at VY is that there was a reduction in the oxygen content of the plant, further increasing the potential for FAC. Dr. Hopenfeld cites in support of this statement page 3.2 of the summary report of the evaluations performed by SIA on environmentally assisted fatigue, provided by NEC as NEC exhibit NEC-JH_18 at 3.2. Do you agree with this assertion?

A44. (JCF) No. First of all, the cited report page does not state that the oxygen content of the plant has been reduced. It simply states that the plant water chemistry was switched to Hydrogen Water Chemistry ("HWC") in 2003. The change to HWC did not change, nor was it expected to change, the oxygen concentrations in the feedwater system, as demonstrated by measured plant data. Exhibit E4-18.

B. CHECWORKS MODELING

Q45. NEC's consultants assert that the EPU of 20% represents a situation where the predictive efficacy of CHECWORKS will be diminished and that data from existing plant experience cannot be used to predict the effect of post uprate conditions. Dr. Hopenfeld (NEC-JH_36 at 15) ("... without specifying how each variable separately effects corrosion, does not address the issue of how the corrosion rate at a given location would be affected when the velocity changes by 20% at a given plant."); Mr. Witte (NEC-UW_03 at 22-23) ("... VYNPS is unique in its approach of Constant Pressure Power Up-rate to 120%"). Do you agree with these assertions?

A45. (JSH) No. Dr. Hopenfeld's and Mr. Witte's statements do not accurately reflect how CHECWORKS incorporates data from other nuclear units. As discussed above, the correlations built into CHECWORKS are based on laboratory experiments on modeled geometries, published correlations, and operating data from many nuclear units.

Mr. Witte's assertion that the use by CHECWORKS of inspection data from other plants is not helpful because the VY conditions after the extended power uprate are different from those at other units denotes a lack of understanding of how CHECWORKS operates. As discussed above, the data used to develop the predictive algorithms in CHECWORKS encompass the conditions at VY after the uprate. The algorithms used to predict the FAC wear rate are based on extensive laboratory and plant data, including data on FAC wear rates where the flow rate and the temperatures exceed those present at VY after the uprate. This assures that the FAC wear rates predicted by CHECWORKS are accurate.

VY is certainly not unique in using CHECWORKS as part of an EPU. Exhibit E4-09 at ¶¶ 19-21.

Q46. Is Mr. Witte's assertion that "... 50% of those [plants] have experienced FAC related problems" (NEC-UW_03 at 23) relevant to the prediction of FAC at VY?

A46. (JSH) No. Mr. Witte's citation does not support his statement. The operating experiences of the plants cited by Mr. Witte are either inapplicable to VY or altogether irrelevant. At Clinton (one of the plants cited by Mr. Witte), three separate instances of piping degradation are reported. The first instance refers to INPO operating experience reports OE17412 and OE18478 (Exhibits E4-13 and E4-14). These reports refer to impingement degradation found in the feedwater heater vent lines. Impingement damage is a form of **erosive** attack, unrelated to FAC.

The second instance refers to INPO operating experience report OE20246 (Exhibit E4-15). This report refers to FAC wear found in extraction lines within the condenser. The report clearly states that the damaged lines were assumed to carry superheated steam (and thus were immune from FAC attack) and were mistakenly excluded from the CHECWORKS model. However, there was enough condensation in the condenser to remove the superheat from these lines, resulting in wet steam which can and did cause FAC wear in these lines. The incident, however, is not relevant to VY because (1) the similar lines at VY are composed of FAC resistant material; and (2) VY does not have a reheater, so there are no superheated lines that might be mistakenly excluded from modeling in CHECWORKS.

The third instance refers to INPO Operating Experience OE17654 (Exhibit E4-16). OE17654 deals with degradation downstream of orifices at the condenser in several systems. The damage mechanism was found to be **cavitation erosion** or **liquid droplet impingement erosion**, not FAC.

At Dresden, the second plant on whose experience Mr. Witte relies, two instances are cited. The first was a loss of condenser vacuum. The experience report, OE21421 (Exhibit E4-17), does not indicate that the cause of the leakage was determined and certainly does not ascribe the cause to FAC. The other instance seems to concern **erosion** on the exterior surface of a vent line within the condenser. This erosion was not degradation due to FAC. In neither case is there any basis for linking the issues to FAC wear or to the implementation of the power uprate at Dresden.

Mr. Witte does not provide a reference for his assertion about Quad Cities. We have made inquiries and have not identified any FAC-related incidents at Quad Cities after its power uprate.

Q47. Dr. Hopenfeld asserts that CHECWORKS and its predecessor codes are not acceptable for predicting FAC because FAC is non-linear and local, and "the required correct inputs that account for local turbulence are not included in CHECWORKS." NEC-JH_36 at 6-7; see also id. at 4, 11, 12, 15. Is this statement correct?

A47. (JSH) No. Dr. Hopenfeld is in error in claiming that FAC is a non-linear phenomenon. Unlike erosion mechanisms, FAC causes damage in a manner that is linear with time (i.e., there is a constant corrosion rate). This has been demonstrated in numerous laboratory tests and by the fact that field measurements match predictions using a linear model. For that reason, laboratory tests designed to measure the impact of, for example, water chemistry on FAC rates are often run for a period of just hours – enough time to establish a trend. In fact, when operating conditions are intentionally changed, the rate of FAC responds almost immediately to the new conditions. See, e.g., Exhibit E4-19; Exhibit E4-08 at 7-6 and Figures 3-6 and 3-7.

With respect to the allegedly local nature of FAC wear, although local FAC wear is occasionally seen – normally near a geometric discontinuity – such local wear usually results in only minor effects (e.g., leaks). The normal feature of FAC wear – widespread wear over an extended area – is what causes significant problems (e.g., the need for pipe replacements or the occurrence of pipe ruptures).

This distinction can be seen by comparing the catastrophic FAC-induced failures, such as the one at Surry, with other instances, such as those described at Calvert Cliffs in OE 15860 (Exhibit E4-20) and OE 20127 (Exhibit E4-21) where localized FAC caused leaks, but not pipe ruptures. By contrast, at Surry, there was not "localized" wall thinning (as Dr. Hopenfeld mischaracterizes the event). NEC-JH_36 at 2. Rather, there was widespread loss of material typical of attack by FAC (Exhibit E4-08 at 1-5). The global nature (i.e., widespread effect) of the FAC damage is consistent with the experience of FAC-induced ruptures. The photographs of failures at Surry, Fort Calhoun, and at a Czech nuclear unit, for example, clearly show the large area of thinned material. (Exhibit E4-08 at Figures 1-3, 4-31 and 4-41).

Dr. Hopenfeld also states that "one must know the exact spot on a given component where conditions are most favorable to FAC." NEC-JH_01 at 12. This statement is clearly incorrect. The NSAC-202L guidance, which is also the practice at VY, calls for the inspection of the entirety of each component and the attached piping or the piping section selected for inspection. The inspection is conducted in sufficient detail to identify any FAC-caused degradation anywhere in the entire location being inspected. In virtually all cases, the degradation caused by FAC occurs over a fairly wide area (comparable to the size of the fitting). Therefore, pinpointing the "exact" location in a component or piping section where FAC will occur is infeasible and unnecessary.

Q48. Do you agree with Dr. Hopenfeld's claim that "it is the local flow velocity that directly controls the local turbulence and not the average velocity" and that CHECWORKS is flawed because it is "based on average flow velocities"? NEC-JH_36 at 7.

A48. (JSH) No. Dr. Hopenfeld is incorrect in claiming that the use of average flow velocities is flawed. Engineering calculations are often premised on the use of average flow velocities. Both Dr. Hopenfeld and Dr. Hausler refer to such an example in their reports (NEC-JH_36 at 3, NEC-RH_01 at 5) – calculating pressure drop in turbulent flow.

When calculating the pressure drop across a component, such as an elbow, an engineer would normally use well-established values to relate the pressure drop in the elbow to the pressure drop in a straight pipe. An engineer would not usually resort to computational fluid dynamics, as Dr. Hopenfeld suggests.

To do so would require the engineer to calculate the flow field relating the average inlet velocity to the local velocity, and then integrate the local shear stress field to obtain the pressure drop.

Similar to the engineer using well-established values of pressure drop and flow velocity in a straight pipe and comparing it to the pressure drop in the elbow, CHECWORKS uses "geometric factors" to relate the maximum degradation occurring in a component, such as an elbow, to the degradation predicted to occur in a straight pipe. This approach was developed by Keller in the 1970s and is similar to the approach taken in other FAC computer programs. The use of geometric factors in the three most prominent FAC programs are presented in Exhibit E4-08 in Table 3-1 at 3-11, Table 7-1 at 7-3, and at 7-7 – 7-8.

Q49. Dr. Hopenfeld claims that "the mass transfer coefficient varies with the 0.8^{th} power of the velocity for straight pipes and the square of the velocity for curved pipes," NEC-JH_36 at 4. Do you agree with this claim?

A49. (JSH) No. The portion of this statement concerning elbows (and by extension other geometries) is incorrect and is contradicted by a large body of mass transfer data and correlations published in the technical literature for the geometries encountered in piping systems. ~~The portion of this statement concerning elbows (and by extension geometries other than straight pipes) is incorrect.~~ For all known geometries including straight pipes, bends, and flow restrictions, the dependence of mass transfer coefficient on velocity is less than unity. For example, data from Tagg, et al. (Exhibit E4-22 at Figure 8) and Poulson and Robinson (Exhibit E4-23 at Figures 5, 6, 8 and 9) shows the exponent on the Reynolds number (i.e., a dimensionless number directly proportional to the velocity) is between 0.5 and unity. This results in a dependence of FAC rate on velocity that is slightly less than linear (i.e., doubling the velocity will not quite double the rate of FAC).

The mass transfer correlations built into CHECWORKS are based on laboratory experiments on modeled geometries, published correlations and plant data from many nuclear units, all of which have shown a less than linear relationship exists between velocity and the rate of FAC wear, including velocities higher than those present at VY after the uprate. The FAC wear rates vary roughly with velocity and do not increase with velocity in the non-linear manner claimed by Dr. Hopenfeld.

Q50. What is your response to Dr. Hopenfeld's observation that "CHECWORKS is not a mechanistic model . . ." and that "the correlation of CHECWORKS was performed in an unscientific manner"? NEC-JH_36 at 12.

A50. (JSH) No existing FAC model is mechanistic. A "mechanistic model" would be based directly on the physical processes involved. The model used in CHECWORKS and other FAC programs takes a broader approach that does not deal with the microscopic processes involved. Instead, it relates physical and chemical parameters with the entirety of the corrosion process. However, the fact that CHECWORKS is not mechanistic does not mean that it is not an effective predictive program. The predictive algorithms in CHECWORKS were developed using all available plant and laboratory data and, therefore approximate, without directly reproducing, the mechanistic details of the corrosion process, such as the rate of mass transport within the porous oxide. The successful use of CHECWORKS and its predecessor programs for more than

20 years provides additional support for the claim that CHECWORKS is an effective tool for inspection planning.

Q51. Does the non-mechanistic nature of the CHECWORKS model affect its ability to be used as part of the VY FAC Program?

A51. (JSH) No. As discussed earlier, CHECWORKS was specifically designed to predict the effects on plants when their operating conditions change. The only relevant parameters that change as a result of the power uprate at VY are flow rate and temperature, both of which are accounted for within the CHECWORKS model.

Q52. Dr. Hopenfeld (NEC-JH_36 at 9-11) and Mr. Witte (NEC-UW_03 at 9-10) refer to several reactors and fossil units where FAC has allegedly not been detected in components, in some instances leading to pipe ruptures. Would you please discuss the operating experience cited and its relevance, if any, to the FAC Program at VY?

A52. (JSH) Generally, Dr. Hopenfeld characterizes these events as: (1) being a failure of CHECWORKS or predecessor programs; or (2) evidencing a failure of the EPRI guidelines. In the cited instances, the events Dr. Hopenfeld cites do not involve one or either of these.

San Onofre. "May 1990 — Erosion and corrosion was discovered in the feed distribution piping of units 2 and 3 at San Onofre — IN 91-019" and "June 1993 — Through wall FAC of two J-tubes in Unit 2 Steam Generator at San Onofre. IN 93-06." NEC-JH_36 at 9-10. The failed components – feed distribution piping and J-tubes – were within the pressure boundary of the steam generator, and as such are not normally, nor were they in this case, modeled using CHECWORKS (or its predecessor programs). The experience at San Onofre was one of the first reported instances of FAC degradation in the feed ring of a steam generator. With respect to the feed distribution piping, NEC's own exhibit, NEC-JH_46, shows that the NRC reported that "[t]he licensee determined that the root cause contributing to the degradation of the feedwater distribution system piping to be inadequate design of the feedring and feedring supports." Id. at 2. Moreover, the EPRI guidelines (NSAC-202L) were not issued until November 1993, after the two events occurred.

Fort Calhoun. "April 1997— 6 square foot rupture of a 12-inch elbow at Ft. Calhoun. IN 97-84." NEC-JH_36 at 9-10. While CHECWORKS was being used at the station, a post-accident investigation by the NRC indicated that the utility failed to use CHECWORKS properly. NEC-JH_51 at 2. The NRC found that, with respect to this event, the FAC engineer should have been aware from the CHECWORKS output that the area should have been investigated, as field measurement results did not match the program's predictions due to modeling errors. Id. at 2.

Mihama. "August 9, 2004 — A secondary pipe ruptured, 5 workers were killed and 6 more were injured at the MIHAMA plant in Japan." NEC-JH_36 at 10. As Dr. Hopenfeld concedes, the operators of Mihama did not use CHECWORKS or other predictive programs; nor did they use an inspection program consistent with NSAC-202L. Rather, they used a Japanese procedure that relied on inspections and trending alone (Exhibit E4-24). There are considerable differences between the Japanese approach prior to Mihama and the U.S. approach, including not using predictive tools like CHECWORKS and not having an industry-wide inspection standard.

Millstone 3. "December 1990 — Two six inch pipes were damaged as a result of wall thinning at Millstone 3. The first pipe completely sheared off while the second was sheared by 1/2 to ¾". The pipe eroded from its original thickness of 0.28 inches to 0.11 inches." NEC-JH_36 at 9. This piping was not analyzed by CHEC or CHECMATE, as NEC-JH_47 makes clear: "Although the licensee had identified the MSD system as one of the systems to be analyzed for erosion/corrosion susceptibility, that analysis was not performed because of a communication error." Id. at 2. Moreover, the EPRI single-phase guidance was not issued until November 1993, after the event occurred.

Susquehanna Unit 1. "May 1992 — Unexpected high erosion rates in the feedwater piping at Susquehanna Unit 1 (BWR) in a section of piping that could not be isolated from the reactor vessel. IN 92-35." NEC-JH_36 at 10. This area was not analyzed with CHEC or CHECMATE. Likewise, the EPRI single-phase inspection guidelines were not in place.

North Anna. "Wear in the feedwater nozzle at North Anna in the safety-related area of the plant." NEC-JH_36 at 10. Dr. Hopenfeld provides no citation for this event.

Sequoyah. "November 1994 — 180-degree crack in a 14" condensate piping at Sequoyah. IN 95-11." NEC-JH_36 at 10. Although the line was analyzed with CHECWORKS, there was an error in modeling the component that resulted in inaccurate results. NEC-JH_50 at 2.

Callaway. "August 1999 — Double ended pipe break in a moisture separator at Callaway. IN 36015." NEC-JH_36 at 10. The event report shows that the event actually occurred in a reheater drain line, not a moisture separator drain line. NEC-JH_45. Although it was analyzed with CHECWORKS and the area in question was inspected, it was not inspected in a manner consistent with NSAC-202L.

Kewaunee. "April 2004 — A work order to inspect the elbow for wall-thinning at Kewaunee was cancelled after wall thickness in a nearby elbow was evaluated by the licensee and deemed acceptable. The extrapolation of inspection results from one elbow to the other elbow was inappropriate." NEC-JH_36 at 10. The line in question is not FAC-susceptible (raw water system). It was not analyzed with CHECWORKS and is not covered by NSAC-202L.

In short, none of Dr. Hopenfeld's examples involve a situation in which proper use of CHECWORKS or its predecessor programs was ineffective in preventing a FAC failure.

Q53. Is there any merit to Mr. Witte's (NEC-UW_03 at 8-9) argument that, because failures have occurred at Surry, Pleasant Prairie [fossil] and Mihama after less than ten years of operation, an extended period of "baselining" would be required?

A53. (JSH) No. Even though accidents did occur after about 10 years of operation at each of these plants, there were no computer programs in use at any of the plants to predict the risk of FAC or to protect piping and components against FAC. There were no inspections of the potentially affected areas or any sort of FAC program at Surry, San Onofre and Pleasant Prairie; nor was there a program in place that would have identified the potential failure location before it occurred. Thus, the operating time before failure had nothing to do with the effective use or accuracy of CHECWORKS. At Mihama, there was a program in place that did not use a predictive methodology, and the accident was caused by a programmatic, not a technical, failure.

Thus, the experiences at the plants cited by NEC do not support NEC's claim that CHECWORKS is unsuitable for its intended purpose, or that an extended period is necessary to calibrate the program after the EPU.

C. ADEQUACY OF VY'S FAC PROGRAM

1. Programmatic Issues

Q54. What is the issue in controversy with respect to the adequacy of VY's FAC Program?

A54. (JSH, JCF) Dr. Hopenfeld and Mr. Witte raise concerns about the implementation of the FAC Program over the last several years.

Dr. Hopenfeld questions the implementation of the FAC Program as it relies on engineering judgment as one of the factors in selecting the locations where inspections will be made during refueling outages. Dr. Hopenfeld questions the importance VY has given to higher flow velocities during EPU operation in selecting the component locations, stating that it is the turbulence of the flow that determines FAC susceptibility. NEC-JH_36 at 12. He also challenges the selection of the highest length of piping as candidates for performing inspections. NEC-JH_36 at 11.

Dr. Hopenfeld further states that "the selection of the correct grid size for UT measurements is one of the most critical inspection tasks" and criticizes the CHECWORKS guidelines for selection of grid size as they are applied at VY. NEC-JH_36 at 7, 14-16.

Q55. Do you agree with Dr. Hopenfeld's assertion that the VY FAC Program at VY is deficient in these respects?

A55. (JSH, JCF) No.

Q56. What is the basis for your disagreement with Dr. Hopenfeld?

A56. (JSH, JCF) There are four areas of criticism by Dr. Hopenfeld, all invalid: use of engineering judgment; velocity versus turbulence; use of pipe length as a basis for selection; and selection of grid size.

The use of engineering judgment as one way of selecting inspection locations is specifically recommended by NSAC-202L. Dr. Hopenfeld states that, "[t]here is no indication that components to be included in the FAC program are selected on the basis of [risk significance and component susceptibility to failure]; instead, component selection is left to the judgment of plant operators." NEC-JH_36 at 8. Entergy's FAC program, however, does take risk significance and component susceptibility to failure into account. Exhibit E4-06, Sections 5.2 and 5.3.

Dr. Hopenfeld's argument that there should be a greater than linear dependence on velocity (NEC-JH_36 at 4) is unsupported and, as discussed earlier, is contradicted by an extensive body of laboratory results (see Exhibits E4-22 at Figure 8 and E4-23 at Figures 5, 6, 8 and 9).

Dr. Hopenfeld (NEC-JH_36 at 11) asserts that Entergy believes "that length and the highest velocities control corrosion." Dr. Hopenfeld bases this assertion on a quote taken from the transcript of the November 30, 2005 Advisory Committee on Reactor Safeguards ("ACRS") meeting. The quoted language contains a transcription error. The discussion around the quotation concerns the inspections to be performed during three upcoming refueling outages. In the discussion, Entergy was stating that, given the low wear rates that had been measured, Entergy would be inspecting the locations that had the highest length of time since the last inspection and the locations with the highest velocities. Dr. Hopenfeld's interpretation of the text as evidencing that Entergy uses the longest length of pipe as a criterion for inspections is incorrect.

Dr. Hopenfeld's assertions criticizing CHECWORKS guidelines for the selection of grid size (NEC-JH_36 at 7, 14-16) are just wrong. The grid size is normally specified in the utility's procedure governing inspections and is not related to CHECWORKS. Usually, this recommendation will follow the guidelines of NSAC-202L. In the case of VY, the grid size is specified by an Engineering Standard, "Flow Accelerated Corrosion Component Scanning and Gridding Standard" (Exhibit E4-25). Historically, grid size is related to the physical size of the component being inspected for degradation. There are two aspects to grid size: (1) when degradation is found, the grid size is normally made smaller in that area to more accurately define the wear area; and (2) in inspecting a component, the larger the pipe, the larger amount of material that may be lost before the component fails, allowing for a "larger" grid (i.e., the defect size that would cause failure varies directly with the size of the pipe). Both of these approaches are consistent with NSAC-202L, Rev. 2, Section 4.5.3.

At VY, an additional step is taken in performing the inspections. Rather than recording the thickness reading at particular grid points, the components inspected at VY are scanned in their entirety. This is done by moving an ultrasonic transducer over the entire surface within a grid "square." The data logger automatically records the minimum reading anywhere within the grid square and the qualified inspector verifies that reading. This ensures that the thinnest readings in the component are found.

Q57. Dr. Hausler (NEC-RH_03 at 9) states: "It would be erroneous for the utility to continue to rely on grids established prior to EPU since these grids may not specifically capture the FAC phenomena observed at lesser velocities." Is his statement correct?

A57. (JSH) No. This statement is not correct. As stated previously, the FAC Program at VY provides for the inspection of **the entirety** of each component and the attached piping or the piping section selected for inspection. Therefore, the size of the grid is the same both before and after the uprate. The inspection is conducted in enough detail to identify any FAC-caused degradation **anywhere** in the entire location being inspected. In virtually all cases, the degradation caused by FAC occurs over a fairly wide area (comparable to the size of the fitting).

2. Alleged Program Implementation Deficiencies

Q58. What historical deficiencies does Mr. Witte allege in the VY FAC Inspection Program?

A58. (JCF) Mr. Witte asserts that data from previous FAC inspections (prior to the EPU) were not entered into the CHECWORKS database (NEC-UW_03 at 2, 3, 6, 7-8, 15, 16, 17);

that CHECWORKS was not updated with the uprate parameters (id. at 5, 23); that, for the period 2000-2006 VY failed to use a current version of CHECWORKS (id. at 6, 17); that four components were predicted in 2004 to have wall thinning beyond operability limits (id. at 17-18, 22); that open corrective actions identified in condition reports may not have been completed (id. at 3-4, 18-19); that ranking of small bore piping was not done (id. at 8, 20); that the number of inspection points were reduced after the 2005 outage (id. at 7, 8, 20); and that the 2006 refueling outage inspection "scope, planning, documentation, and procedural analysis appear to have been performed under a superseded program document" (id. at 5, 7, 20-21).

Q59. Do you agree with these criticisms?

A59. (JCF) No. Each of these criticisms either demonstrates a misunderstanding of the FAC Program on the part of Mr. Witte or is erroneous.

Q60. Mr. Witte states (NEC-UW_03 at 15) that Entergy was "aware of the problematic state of the program for many years" and describes (NEC-UW_03 at 2, 18) the FAC Program as "unsatisfactory." Do you agree with these statements?

A60. (JCF) No. Mr. Witte is making an assertion regarding the FAC Program being "problematic" that is not supported by the document he cites. Mr. Witte cites NEC-UW_09 as the basis for Entergy being "aware of the problematic state of the program" (NEC-UW_03 at 15), but that document is a quality assurance audit, No. QA-8-2004-VY-1 (Exhibit E4-26), which categorically states that "[n]one of the findings or areas for improvement, individually or in the aggregate, were indicative of significant programmatic weaknesses which would impact the overall effectiveness of the Engineering Programs assessed." Id. at 2. Nor does Mr. Witte try to explain what significance, if any, this quality assurance audit has with respect to the adequacy of the FAC Program.

Q61. Mr. Witte (NEC-UW_03 at 15) states that VY was, "...notified by EPRI as early as 2000 that it had not been fully updating the CHECWORKS model in use at VYNPS with plant inspection data collected or plant modifications performed during previous inspections. Entergy apparently ignored the warning." Is Mr. Witte's statement factually accurate?

A61. (JCF) No. The statement is inaccurate. The EPRI evaluation report (Exhibit E4-27) was received in February 2000. The CHECWORKS models were updated with all applicable inspection data during the Summer and Fall of 2000. Exhibit E4-28. Additional updates were performed for the feedwater system in 2003. Exhibit E4-29. Another CHECWORKS update was performed in 2006. Exhibit E4-30.

Q62. Mr. Witte makes several other statements to the effect that CHECWORKS was not properly updated with data from previous FAC inspections (prior to the EPU) (NEC-UW_03 at 2, 3, 6, 7-8, 15, 16, 17). Do you agree with these statements?

A62. (JCF) No. Each of these statements is essentially a repetition of the assertion addressed in my previous answer.

Mr. Witte makes other inaccurate statements regarding VY's input of data into CHECWORKS. He asserts that the "model was not kept current during a seven-year period and suggests that susceptible locations may not have been inspected during this time period." NEC-UW_03 at 16. In fact, all applicable inspection data were updated during the Summer and Fall of 2000. Additional updates were performed for the feedwater system in 2003. In addition, inspections performed in 2001, 2002, 2004, and in 2005 showed that the wear rates predicted by the CHECWORKS model were consistently conservative;

thus the alleged failure to "update" the CHECWORKS model would not have resulted in under-prediction of the FAC risks because the inspection planning and component selections made during those outages were based in part on the conservatively high wear rates predicted by CHECWORKS. The CHECWORKS update performed in 2006 confirmed again that the previously predicted wear rates were conservative. Exhibits NEC-UW_10 and E4-31.

Mr. Witte's conclusion that the purported failure to update CHECWORKS "suggests that susceptible locations may not have been inspected during this period" is only unfounded speculation. In fact, all susceptible piping was identified independently from the CHECWORKS results. Exhibit E4-32.

In implementing the FAC Program at VY, the original CHECMATE and later CHECWORKS Pass 1 Analyses (performed with the initial use of CHECMATE and CHECWORKS) calculated FAC wear rates and predicted time to minimum wall thickness based on plant-specific variables. Under the FAC Program, inspections were then performed for the components with the highest wear rates and lowest time to minimum wall thickness. As inspection data were obtained and incorporated into the models, Pass 2 Analyses were performed and the predicted wear rates were correlated to the measured data. In all cases, the inclusion of the inspection data reduced the predicted wear rates and increased the times to minimum wall thickness. Thus, not entering data from a particular inspection into CHECWORKS would not suggest that "susceptible locations may not have been inspected," as Mr. Witte asserts.

The data and inspection reports clearly indicate that Mr. Witte's statement has no basis. Exhibits E4-35 through E4-38. The CHECWORKS update performed in 2006 confirmed that the previously predicted wear rates (before the 2006 update) were conservative (see Exhibits NEC-UW_10 and E4-31) and the results of the updated model did not identify any instance where recommended inspections were not performed. Exhibit E4-31.

Contrary to Mr. Witte's assertion, there was no lapse related to the FAC Program. The susceptibility analysis was updated in October 2005 to include changes in the relevant input variables – flow rate and temperature – associated with the power uprate. Exhibit E4-32.

Q63. Mr. Witte states (NEC-UW_03 at 19) that "the VY FAC program was *prima facie* in noncompliance with its CLB" because "in 2005 a sixth CR was written, CR-VTY-2005-02239, stating 'CHECWORKS predictive model for Piping FAC inspection program was not updated per appendix D of PP 7028'". Is he right?

A63. (JCF) No. Comparison of the CHECWORKS predictions with subsequent inspection data showed that the CHECWORKS predictions were conservative (i.e., predicted higher wear rates than observed during the inspection). For that reason, even if the most recent inspection data had not been entered into the CHECWORKS program, the result would have been over-estimation of FAC wear. The CR cited by Mr. Witte correctly concludes, therefore, that not updating the CHECWORKS database with the most recent inspection data was not necessary in order to determine the appropriate scope of the RFO 25 inspection.

There is no basis for Mr. Witte's assertion that not entering the most recent inspection data into CHECWORKS rendered the FAC Program in noncompliance with VY's current licensing basis ("CLB"). VY's CLB incorporated the recommendations in EPRI NSAC-202L, Rev.2 (Exhibit E4-33) by reference in FAC Program Procedure(s) PP7028 (Exhibit E4-34) and, later, ENN-DC-315, Rev.1 (NEC-UW_12), which were in effect during the period from 1999 to 2006. Section 4 of NSAC-202L, Rev. 2, does not specify a specific interval for model updates. It merely states: "It is recommended that whenever possible, the Predictive Plant Model utilize the results of wall thickness inspections to enhance the FAC predictions. In CHECWORKS this is called Pass 2 analysis."

Because there is no specific interval required for entering additional inspection data into CHECWORKS, no departure from the CLB took place.

Q64. Mr. Witte also states (NEC-UW_03 at 19): "From 1999-2006, the plant was essentially operating in a state in which component wear was improperly trended and pipe conditions were actually unknown. Reliance on CHECWORKS for this time period for predicting grid points, ranking susceptible components, and inspecting new points was therefore virtually without technical or empirical value." Is there any validity to his conclusions?

A64. (JCF) No. Mr. Witte's assertions assume (1) that CHECWORKS was the only tool used for choosing inspection points, and (2) that trending of component wear is a necessary part of CHECWORKS use. Neither assumption is true. During the time period that Mr. Witte references, inspections were conducted, data were evaluated, and component wear rate was trended, all in accordance with the FAC Program. The results of these inspections, data evaluations and trending have been provided to NEC (Exhibits E4-35 through E4-38). Significantly, Mr. Witte does not point to any deficiency in those records.

Q65. Mr. Witte states (NEC-UW_03 at 17): "During the years 2000-2006, the VYNPS FAC program apparently used an outdated version of the CHECWORKS software. As far back as 2000, EPRI recommended that VYNPS update to the current version of the software, but the recommendation was not implemented until 2006." Is this a correct statement?

A65. (JCF) No. As noted earlier, VY updated the version of CHECWORKS it used from CHECWORKS FAC 1.0D to CHECWORKS FAC 1.0F in 2000. Exhibit E4-28. Version 1.0F was used for the 2003 and 2006 model updates. CHECWORKS FAC 1.0G was installed in 2006.

More fundamentally, Mr. Witte does not state what consequences would follow from the failure to use the most current version of CHECWORKS. In fact, there were no differences in versions 1.0D, 1.0F, and 1.0G with respect to water chemistry and wear rate predictions for BWRs (see Exhibit E4-39). Nothing regarding the version in use at any particular point in time had any effect on the use of CHECWORKS as a tool as part of the FAC Program. Nor would it have any effect on the implementation of the FAC Program during the license renewal period.

Q66. Mr. Witte states (NEC-UW_03 at 17) that "[i]n 2004, at least four VYNPS components, including the condensate system and the extraction steam systems, were determined to have 'negative time to Tmin,' meaning that wall thinning was being predicted as beyond operability limits and should be considered unsafe with potential rupture at anytime." What is the significance of the statement quoted by Mr. Witte?

A66. (JCF) Mr. Witte's interpretation of this assertion demonstrates his misunderstanding of how CHECWORKS is used at VY. The document to which Mr. Witte refers for support for these statements is the VY Scoping Worksheets (Exhibit E4-40 at 5) developed in preparation for the 2004 refueling outage. These statements refer to the predicted wear based on the CHEC-WORKS wear rates which, as discussed above, had previously been determined to be conservative.

Mr. Witte fails to clarify that the "determination" that the four components had "negative times to Tmin" is a theoretical conclusion based on the results of CHECWORKS, and is not based on actual inspection data. As such, there would be no need to "write condition reports for this condition," (NEC-UW_03 at 18) as Mr. Witte states. CRs are written when inspection data indicate there is an actual problem and additional inspections are then performed as corrective actions. If a planning tool, like CHECWORKS, indicates an area of potential concern, inspections of that area are scheduled.

The only FAC susceptible component identified in the 2004 Scoping Worksheets (CD30TE02DS) was scheduled for inspection. The actual inspection data show that the entire component meets design code with significant margin. See Exhibit E4-37 at 12.

Q67. Mr. Witte states (NEC-UW_03 at 19): "The 2006 cornerstone report shows a number of indicators as yellow, with lists of open CR corrective actions, and a new CR written in August 30, 2006. The report lists six corrective actions and four CRs that were written as early as 2003 that remain open." Is this an accurate characterization?

A67. (JCF) The statement is inaccurate. The FAC Program Health Report, "Cornerstone Rollup" shows the overall FAC Program status as Green. Exhibit NEC-UW_07 at 1. The report rates twenty-seven different areas. Of these, two were rated as "Yellow": (1) Owner Availability and (2) Open Actions

Items. Id. at 4, 6. A yellow indicator for Open Action Items is triggered if any action item, regardless of its importance, is more than one year old. Six LO-VTYLO action items are listed. These are not Condition Reports, nor are they corrective actions from condition reports. They are commitments. The Corrective Action Program is used to track all commitments. There is no safety significance to these commitments. The items listed are for completion of program administrative tasks.

Q68. Mr. Witte states (NEC-UW_03 at 20): "Ranking of small bore piping was not done. With no ranking, the basis for selection of high susceptible points for small bore piping is not evident." Is this statement accurate?

A68. (JCF) This statement is not accurate. At VY, the initial scoping and inspection selection of small bore piping was performed in 1993 and 1995. The scope and criteria for determining the inspection locations is documented in FAC Program documents (Exhibits E4-41 and E4-42). The small bore inspections were initiated prior to the inclusion of small bore guidance provided in NSAC-202L.

Q69. Is Mr. Witte (NEC-UW_03 at 20) correct when he states: "A flow-accelerated corrosion related pipe break associated with a 1" elbow, SSH (WO 06-6880), appears to have occurred in 3rd quarter 2006"?

A69. (JCF) No. A pinhole leak was identified during operator rounds on an elbow on the 1" drain line from the steam seal header to the condenser. No "pipe break" had occurred. The elbow was replaced in RFO 26. The damage found was due to droplet impingement, not FAC.

Q70. Mr. Witte states (NEC-UW_03 at 20): "Entergy apparently reduced the number of FAC inspection data points between the 2005 and 2006 refueling outage, in violation of its commitment to increase inspection data point by 50% The 2005 refueling outage inspection called for 137 large-bore inspection points. The 2006 refueling outage inspection presented to the ACRS on June 5, 2007, covered only 63 points." Do you agree with Mr. Witte's statement?

A70. (JCF) No, the statement is inaccurate. First, there was no refueling outage in 2006. Second, in RFO 25 in the Fall of 2005, a total of 35 inspections were performed. Of those, 27 were large bore UT inspections. Exhibit E4-38. In RFO 26 (conducted in the Spring of 2007), a total of 63 inspections were performed. Of those, 41 were large bore UT inspections. Exhibit E4-38. The increase in the number large bore UT inspections from RFO 25 to RFO 26 was more than 50%, in accordance with Entergy's plans.

Q71. Mr. Witte states (NEC-UW_03 at 20): "The 2006 Refueling outage FAC Inspection scope, planning, documentation, and procedural analysis all appear to have been performed under a superseded program document. ENN-DC-315 Rev.1 was effective March 15, 2006." Is Mr. Witte correct?

A71. (JCF) No, the statement is inaccurate. There was no 2006 refueling outage. Additionally, the guidance used to perform the scoping had not been superseded. The scoping process for RFO 26 started before RFO 25 was complete and well before the March 15, 2006 effective date of ENN-DC-315, Rev.1 (NEC-UW_12). The RFO 26 scoping was performed using the same criteria as contained in Section 5.3 of ENN-DC-315, Rev.1. The scoping criteria in ENN-DC-315, Rev. 1, is the same as under the superseded VY procedure PP 7028 (Exhibit E4-34, Appendix E, Section E.2).

The most recent FAC inspections, performed in RFO 26, were performed under the appropriate versions of the Entergy procedures EN-DC-315, Rev.0 and ENN-NDE-9.05.

V. SUMMARY AND CONCLUSIONS

Q72. Please summarize your testimony.

A72. (JSH, JCF) Our testimony can be summarized as follows:

- Entergy has had an effective FAC Program in place at VY for over twenty years. The program has detected wear as designed and components have been replaced prior to thinning below minimum design thickness.

- VY is a relatively small and simple plant that has fewer FAC-susceptible piping components than a typical plant of comparable size. The piping and components in many of the two phase flow systems were either originally constructed of FAC-resistant materials or have been replaced with FAC-resistant piping and components since their initial installation.

- The FAC Program at VY uses CHECWORKS as a tool in planning inspections, evaluating inspection data, and managing the UT data collected. While an effective tool, it is only one of several used in the VY FAC Program to identify the locations to be inspected during refueling outages of the plant.

- No nuclear power plant properly using CHECWORKS has reported a large bore piping failure.

- CHECWORKS has a well-established track record of use in FAC management programs, including BWRs which have undergone uprates. The input of new values for the plant-specific variables affected by the uprate at VY – flow rate and temperature – is all that is required for CHECWORKS to continue to be used as part of the FAC Program.

- The current FAC Program, which will be the FAC Program used during the license renewal period, meets industry practice as reflected in NSAC-202L and has been reviewed, audited and inspected with only minor, mostly administrative, issues identified.

- The FAC Program that will be used during the period of extended operation after license renewal will assure that the aging effects of FAC will be adequately managed.

Q73. What are your conclusions regarding the assertions in NEC Contention 4?

A73. (JSH, JCF) We conclude that there is no factual support for the claims made in NEC Contention 4.

Q74. Does that conclude your testimony?

A74. (JSH, JCF) Yes, it does.

MR. LEWIS: At the same time, Entergy moves to introduce Exhibits E4-02 through E4-43. These are Entergy's exhibits that are referenced in the testimony and relate to this contention. There was on exhibit E4-08 which was missed three pages in the copying. The copies have been given to the court reporter and the parties now have the three missing pages added. It was a fact reference booklet with missing pages. We move those exhibits into evidence at this time.

(Whereupon, the documents referred to were marked as Entergy Exhibits E4-02 through E4-43 for identification.)

JUDGE KARLIN: Any objections?

(No verbal response.)

Hearing none, they're admitted.

(The documents referred to having been previously marked for identification as Entergy Exhibits E4-02 through E4-43, were received in evidence.)

Anything else, Mr. Lewis?

MR. LEWIS: That is it.

JUDGE KARLIN: Thank you. NRC Staff

please.

MR. SUBIN: I direct this to Mr. Hsu and Mr. Rowley. Do you have before you the affidavit of Kaihwa R. Hsu and Jonathan G. Rowley concerning NEC Contention 4, Flow Accelerated Rate Corrosion and the rebuttal to this contention?

MR. HSU: I do.

MR. ROWLEY: Yes.

MR. SUBIN: Did you prepare this testimony for this proceeding?

MR. ROWLEY: Yes.

MR. HSU: Yes.

MR. SUBIN: Okay. Do you have any corrections or additions of this testimony?

MR. HSU: Yes.

MR. SUBIN: Can you state that for the record?

MR. ROWLEY: Corrections. On Question 21, change "pease" to "please."

On Question A, answer B, delete "license" and insert "were the" after "evaluate of."

On Question A8, change "managed" to "management." Same question, change "program" to "programs." Change "program generically" to "programs generically." Change "existing program" to "existing programs."

Question A10, insert "a" before "computer code."

Question A14, change "model" to "model's."

Change Question A15 to insert "a" before "FAC."

Question A17, insert the word "the" before "CHECWORKS."

Question A18, insert "of" after the word "input."

Question Q19, insert "are needed" after "cycles."

Question A19, I guess, like 12, insert "of" after "five to tens years."

Question Q20, line 3, delete the extra period.

Question A22, line four, insert a period after the word "plant."

Question A24, line nine, change "increase" to "increases."

Question A24, line 11, change "ware" spelled W-A-R-E to "wear" spelled W-E-A-R.

Question A25, line four, delete "instead."

Question A26, Answer A26, line nine, delete the word "to" after "CHECWORKS."

A27, line four, delete "to" after "continue." A27, line five, insert "in" after "parameter."

A28, line three, delete "necessary" after "need to."

Q30, line one, change "managing" to "manage."

A30, line two, insert "that" after "mine." A30, line three, change "selected" to select." A30, line four, change "structurally" to "structural."

Q31, line one, delete "to" after "modify."

A32, line eight, insert "for the following four reasons." A32, line 33, change "ruptured" to "rupture." A32, line 37, change "the" to "that."

A34, line five, insert "to be" before "acceptable."

A35, line four, delete "of" after "selecting." A35, line nine, insert "of" after "section."

A37, line six, insert "the" before "EPU." A37, line six, insert "the" between "of" and "last." A37, line 11, change "used" to "use."

Q38, line one, change "Q38.." to "Q38."

A39, line three, change the comma to a semicolon. A39, line five, change the period after

"EPU" to colon "and." And A39, line nine, insert "due to" after "aging."

MR. SUBIN: Do you adopt your testimony as your testimony in this proceeding?

MR. ROWLEY: We do.

MR. SUBIN: I move to have this testimony admitted to the transcript as it is read.

(Whereupon, the document referred to was marked as NRC Staff Exhibit No. for identification.)

JUDGE KARLIN: Thank you, Mr. Subin. Any objections?

(The document referred to having been previously marked for identification as NRC Staff Exhibit, was received in evidence.)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.	))	Docket No. 50-271-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF KAIHWA R. HSU AND JONATHAN G ROWLEY
CONCERNING NEC CONTENTION 4 (FLOW-ACCELERATED CORROSION)

Q1. Please state your name, occupation, and by whom you are employed.

A(a). My name is Kaihwa R. Hsu ("Hsu").[1] I am employed by the NRC as a senior mechanical engineer in the Engineering Division in the Office of New Reactors ("NRO"). Previously I was employed as a materials engineer in the office of Nuclear Reactor Regulation ("NRR") Division of License Renewal ("DLR"). A statement of my professional qualifications is attached to my affidavit concerning NEC Contention 3 (Staff Exh. 4).

A(b). My name is Jonathan G. Rowley ("Rowley"). I am employed by the NRC as a project manager in NRR/DLR. A statement of my professional qualifications is attached to my affidavit concerning NEC Contention 3 (Staff Exh. 4).

Q2. Please explain your duties in connection with the Staff's review of the License Renewal Application ("LRA") submitted by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. ("Entergy," "Applicant," "Licensee," or "Vermont Yankee").

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[1] In this testimony, the sponsors of each numbered response are identified by their last name; no such designation is provided for paragraphs which are sponsored by both witnesses.

A(a). (Hsu) In connection with the Staff's review of the LRA, I was as an Audit Team Member for the license renewal safety audit at Vermont Yankee, and I served as a technical lead for activities related to the Vermont Yankee LRA. I also reviewed the Vermont Yankee LRA including the following aging management programs: B.1.4, "BWR Penetrations;" B.1.5, "BWR Stress Corrosion Cracking;" B.1.6, "BWR Vessel ID Attachment Welds;" B.1.7, "BWR Vessel Internals;" and B.1.29, "Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel," including preparation of Section 3.0.3.1.2 of the Safety Evaluation Report. I also reviewed the Time-Limited Aging Analysis and prepared Sections 4.1, 4.3 and 4.7 of the Safety Evaluation Report.

A(b). (Rowley) In connection with the Staff's review of the LRA I am the lead project manager ("PM") for the Staff's safety review of the Vermont Yankee license renewal application. As the PM, I am the principal point of contact in NRR for activities related to the Vermont Yankee LRA. I coordinated the staff's evaluation of the Vermont Yankee LRA and preparation of the staff's Safety Evaluation Report with Confirmatory Items, which was issued to the public in March 2007. In addition, I coordinated the staff's final Safety Evaluation Report (SER) (Staff Exh. 1), which was issued to the public in February 2008.

Q3. What is the purpose of your testimony?

A3. The purpose of this testimony is to present the staff's position regarding NEC Contention 4 (Flow-Accelerated Corrosion). As admitted by the Board, LBP-06-20, 64 NRC 131, 192-96 (2006), NEC's contention alleges that "Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of plant piping due to flow-accelerated corrosion during the period of extended operation." We have read relevant portions of: LPB-06-20, 64 NRC 131 (2006) (admitting NEC Contention 4); NEC's "Petition for Leave to Intervene, Request for Hearing and Contentions" (May 26, 2006); "Entergy's Motion for Summary Disposition of New England Coalition's Contention 4 (Flow Accelerated Corrosion) (June 5, 2007); NEC's "Opposition to Entergy's Motion for Summary Disposition of NEC's Contention 4 (Flow-Accelerated Corrosion) (July 16, 2007); and "Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 4)" (August 10, 2007) (unpublished).

Q4. What is flow-accelerated corrosion?

A4. (Hsu) Flow-accelerated corrosion is also known as erosion-corrosion. It is corrosive attack accelerated by high velocity flow, either washing away otherwise protective films or mechanically disturbing the metal itself.

Q5. Describe Entergy's program to monitor and manage the aging of plant piping at Vermont Yankee due to flow-accelerated corrosion (FAC).

A5. Implemented in accordance with the EPRI guidelines, Vermont Yankee's FAC program predicts, detects, and monitors FAC in plant piping and other pressure retaining components. The program includes (a) an evaluation to determine critical locations, (b) baseline inspections to determine the extent of thinning at these locations, (c) follow-up inspections to confirm the predictions, or repairing or replacing components. SER Section 3.0.3.1.2 (Staff Exh. 1). The program also includes expansion of the scope when significant wall thinning is discovered in a component.

Q6. Describe how Vermont Yankee selects piping components for UT inspection?

A6. The criteria for selecting components for inspection are described in VY program procedure PP7028 as identified in letter BVY 04-008 (January 31, 2004)

(ML040480640) (Staff Exh. 17). The criteria for selecting specific components for examination during a refueling outage include (1) CHECWORKS predictive models, (2) components identified during previous inspections, (3) industry experience, (4) susceptible piping not modeled by CHECWORKS, and (5) plant specific experience and engineering judgment.

Q7. Describe how Vermont Yankee plans to use CHECWORKS as an aging management tool.

A7. (Hsu) Vermont Yankee uses CHECWORKS as a tool for selecting components for inspection during a refueling outage. For piping without inspection data, CHECWORKS is used to select the most susceptible components on a line or section of piping for inspection. For piping with previous inspection data, CHECWORKS is used to select the components that have the highest wear rate and lowest failure time for inspection.

Q8. Describe the Staff's review of Vermont Yankee's program

A8. The Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (SRP-LR) provides guidance to NRC staff reviewers. The Staff perform safety reviews of aging management programs in accordance with 10 C.F.R. Part 54. In a Staff paper (SECY 99-148), '"Credit for Existing Programs for License renewal," dated June 3, 1999 (Staff Exh. 18), the Staff described options and provided a recommendation for crediting existing programs to improve the efficiency of the license renewal process. In a Staff Requirements Memorandum (SRM) dated August 27, 1999, the Commission approved the Staff's recommendation and directed the Staff to focus the review guidance in the SRP-LR on areas where existing programs should be augmented for license renewal. Under the terms of the SRM, the SRP-LR would reference a "Generic Aging Lessons Learned" (GALL) report, which evaluate existing programs generically, to document (1) the conditions under which existing programs are considered adequate to manage identified aging effects without change and (2) the conditions under which existing programs should be augmented for this purpose. The GALL Report (NUREG-1801) has been treated as an approved topical report. Vermont Yankee's FAC program is an existing program. The staff assessed ten program elements (scope, preventive actions, parameters to be monitored or inspected, detecting of aging effects, monitoring and trending, acceptance criteria, corrective actions, conformation process, administrative controls, and operating experience) to verify their technical adequacy.

By letter dated March 2, 2006 (ADAMS accession number ML060050024) (Staff Exh. 14), the NRC granted Vermont Yankee a 20% extended power uprate (EPU). This can affect aging management. NUREG-1800 "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" Rev. 1 (September 2005) ("SRP") (Staff Exh. 19) Section 3.0.2 states that, "All LRAs with an approved EPU will be required to perform an operating experience review and its impact on aging management programs for structures, and components before entering the period of extended operation." That section of the SRP further provides: "One way for an applicant with an approved EPU to satisfy this criterion is to document its commitment to perform an operating experience review and its impact on aging management programs for systems, structures, and components (SSCs) before entering the period of extended operation as part of its license renewal application." Vermont Yankee SER Commitment No. 51 (Staff Exh. 1) states that "Entergy will perform an evaluation of operating experience at EPU levels prior to the period of extended operation to ensure that operating experience at EPU levels is properly addressed by the aging management programs. The evaluation will include Vermont Yankee and other BWR plants operating at EPU level." This Commitment addresses the SRP's recommendation and is therefore acceptable to the Staff.

In the safety evaluation of the EPU (ML060050028)(Staff Exh. 14), the staff reviewed Vermont Yankee's evaluation of the effect of the proposed EPU on the FAC analysis for the plant and concluded that the applicant adequately addressed the effect of changes in plant operating conditions on the FAC analysis.

Q9. What did the Staff conclude about Vermont Yankee's FAC aging management program?

A9. The program will predict the loss of material by FAC and will ensure timely repair or replacement of degraded components. The staff concludes that Entergy has demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation. SER Section 3.0.3.1.2 (Staff Exh. 1)

Q10. Describe your knowledge of CHECWORKS?

A10. (Hsu) During my previous employment at Westinghouse, I was assigned to develop a computer code, Corrosion Erosion Monitoring System (CEMS), to manage FAC for nuclear power plants. I accumulated my knowledge of CHECWORKS through audit and self-study. CHECWORKS software helps identify what piping is most susceptible to FAC. CHECWORKS is a way to set priorities to mitigate FAC related damage in advance of failure. CHECWORKS was developed and benchmarked by using data from many plants. CHECWORKS is used to select the most susceptible components for inspection and calculate wear rates to predict when the component will reach the minimum allowable thickness. Follow-up inspections are used to confirm the predictions.

Q11. Describe CHECWORKS.

A11. (Hsu) CHECWORKS was developed and benchmarked using data from many plants. CHECWORKS is a tool used to select the most susceptible components for inspection and calculate wear rates to predict when the components will reach the minimum allowable thickness. Follow-up inspections throughout the life of the plant are used to confirm the predictions. Plants using CHECWORKS must input plant specific operating parameters to effectively use CHECWORKS to perform component susceptibility rankings. Once data from inspections is entered into CHECWORKS, which determines the actual wear rate and recalibrates itself, the predicted wear rates and thickness values are adjusted to reflect the actual wear from the inspection data. In other words, wear rates and wear rate predictions are based on actual inspection data.

Q12. What is "benchmarking"? What does "benchmarking" mean?

A12. (Hsu) Benchmarking is a comparison of non-established results with established/recognized results. The CHECWORKS model has to be calibrated with data from inspections to calculate actual wear and the line correction factor. The line correction factor in CHECWORKS is used to adjust wear rate predictions in a given line to account for plant operating conditions that may vary with time. It is determined by comparing predicted wear to measured wear at locations in the line which have been inspected. The so-called benchmarking is really the continuous recalibration process.

Vermont Yankee will continually use the model to identify areas to inspect and feed data into CHECWORKS. It's an ongoing cycle, a living program. However, CHECWORKS is a tool to set priority to mitigate FAC related damage in advance of failure. NEC's experts consider recalibration as benchmarking. In reality, CHECWORKS still cannot determine the absolute wear with many recalibrations since corrosion is not an exact science due to epistemic and aleatory uncertainty which cannot be eliminated.

Q13. What is "calibrating"?

A13. (Hsu) Calibrating means to input plant-specific data into the CHECWORKS program in order to model FAC at the plant and to predict and rank FAC susceptible locations.

Q14. GALL Section XI.M17 (Staff Exh. 7) states: "CHECWORKS was developed and benchmarked by using data obtained from many plants." Explain what "benchmarking" means as used in GALL Section XI.M17.

A14. (Hsu) CHECWORKS was developed to model how FAC wear rates are affected by the alloy composition, fluid pH level, control amine, hydrazine concentration, dissolved oxygen, fluid velocity, component geometry, upstream influences, fluid temperature, and steam quality. CHECKWORKS is an empirical model, meaning that the CHECWORKS model for wear rate predictions was developed using the data from many plants and laboratory experiments. CHECWORKS was "benchmarked" by comparison to the CHECWORKS model's predicted susceptible locations with actual wear data obtained from nuclear power plants and additional laboratory data. This comparison showed that the CHECWORKS model accurately predicts FAC behavior. No further "benchmarking" of CHECWORKS is needed. All that is needed is calibration of CHECWORKS to model plant-specific conditions.

Q15. If CHECWORKS was developed and benchmarked using data obtained from many plants, explain why a plant would need to "benchmark" CHECWORKS using plant specific data. If it's not necessary to benchmark using plant specific data, explain why.

A15. (Hsu) The CHECWORKS program has been benchmarked. To model and predict FAC at a given plant, the user must calibrate the CHECWORKS program to plant specific conditions by inputting plant parameters into the program. There is, however, no way to predict wear with absolute certainty due to epistemic and aleatory uncertainty. Corrosion is not an exact science. It depends on many small, unique, local variables. It is not like manufacturing widgets, where if you use the same amount of material produced in the same way, you end up with identical widgets. In a typical nuclear plant, there may be 5,000 susceptible components, but the plant may only be able to inspect less than a hundred during an outage. CHECWORKS helps identify which piping is most susceptible to FAC and helps set inspection priorities. This is the reason that a FAC program is continued throughout plant life.

Q16. NEC's expert(s) have asserted that CHECWORKS requires continuous "benchmarking." Are NEC's experts correct? Explain.

A16. (Hsu) No, there is no way to get absolute wear rates even with continuous benchmarking or years of calibration. The most important part in using CHECWORKS is evaluating what the model is telling and applying engineering judgment (which is informed by plant operating experience, industry experience, and NRC generic communications) to select appropriate inspection locations. NEC expert's intention is to try to use continuous recalibrations to get absolute wear. However, Vermont Yankee will continuously use CHECWORKS as a tool and will continuously input data from inspections into the CHECWORKS database throughout plant life. This action could meet NEC expert's intent of continuous benchmarking.

Q17. NEC asserts that plant specific data needed to calibrate or recalibrate the CHECKWORKS model? Is NEC correct? Explain.

A17. (Hsu) Yes, plant specific data is needed to calibrate the CHECWORKS model. For example, water chemistry improvement will reduce corrosion; piping material has been replaced with FAC-resistant material, etc. Related plant data has to be entered into the CHECWORKS model to reflect the actual plant conditions.

Q18. Is plant specific data needed in order to use CHECWORKS as part of a program to manage flow-accelerated corrosion? Explain why or why not.

A18. (Hsu) Plant specific data is needed to use CHECWORKS appropriately for susceptible ranking purposes. The CHECWORKS model's empirical wear rate predictions require input of plant specific operating parameters. However, once actual inspection data is included in the CHECWORKS model, the predicted wear rates and thickness values are statistically factored to reflect the actual wear from the inspection data.

Q19. If plant specific data is needed to use (i.e. calibrate) CHECWORKS, how many cycles are needed? If not, explain why.

A19. (Hsu) It requires a minimum of two cycles of inspection data to obtain actual wear for a component. The data from those inspections is entered into CHECWORKS, which determines the actual wear and recalibrates itself. However, the FAC program is continued throughout plant life and inspection data is continually entered into CHECWORKS as part of an ongoing cycle, making CHECWORKS a living program. To use CHECWORKS effectively the user must evaluate what the model is telling him or her and apply engineering judgment informed by plant-specific and industry operating experience, including NRC generic communications, to select appropriate inspection locations. Follow-up inspections are used to confirm the wear prediction.

NEC referenced as industry guidance, Chockie Group International, "Aging Management and Life Extension in the US Nuclear Industry" (October 2006) (Exh. NEC-UW_13 at 38) in support their assertion that 5-10 years of data trending is necessary. The referenced industry guidance, however, quotes the development of the Preventive Maintenance Basis Program (PM basis) by EPRI for a plant's equipment performance and reliability. The guidance states that:

> In order to establish a baseline for the plant's equipment performance and reliability, the operating history over the last 5 to 10 years is reviewed and trended. Typically, the plant will have a work order database from which the preventive and corrective work orders can be accessed. A simple count per year will provide a meaningful trend to see if maintenance activities are increasing, decreasing or portray a stable trend. Also, the ratio of preventive to corrective work orders will provide some indication for a successful maintenance program (corrective work orders are decreasing), or the trend will point to problems, that is failures are increasing as an indication of progressive aging problems.

According to the guidance referenced by NEC, the 5 to 10 year recommendation is for preventive maintenance programs to count the number of work orders for major equipment maintenance improvement as an additional program which is not addressed by the GALL Report. The GALL Report does not consider regular/routine maintenance to be an age-related issue. Therefore there is no requirement to consider regular maintenance activities as aging management programs. This NEC-referenced industry guidance credits the GALL Report (NUREG-1801) and the SRP (NUREG-1800) for the existing programs, such as FAC program and does not suggest additional limitations as NEC claims.

Q20. Is additional plant-specific data necessary in order to recalibrate CHECWORKS following a significant change in plant parameters such as an EPU? If so, how many cycles of data are needed and why? If not, explain why.

A20. (Hsu) As stated above, two cycles of inspection data are usually needed to recalibrate CHECWORKS following a change in plant parameters. Instead of entering inspection data into CHECWORKS, it is also acceptable to enter inspection data into a spreadsheet program for purposes of trending/predicting FAC. However, in the case of Vermont Yankee, only one cycle of inspection results is needed for trending. Section 2.1.6 of Safety Evaluation Report for Vermont Yankee's Extended Power Uprate (ML060050028) (Staff Exhibit 14) stated that "The licensee has determined that an increase in the velocities in the main steam line and feedwater lines will cause proportional increases in FAC wear rates." The staff agreed with Vermont Yankee's determination in its SER for the EPU. At the June 5, 2007, ACRS subcommittee meeting to discuss the LRA, Vermont Yankee officials reported that they had completed 63 inspections and the results were satisfactory. Exh. NEC-UW_11 at 43. In fact, the results were consistent with analytical predictions that Vermont Yankee used in its modeling for FAC. Thus, Vermont Yankee only needs one cycle of inspection results to confirm FAC wear rates for the EPU period if previous inspection data has established a baseline (but two more inspections will be completed prior to the period of extended operation and inspections will continue throughout the period of extended operation). Inspection data beyond what is needed to recalibrate CHECWORKS can be used to further confirm FAC wear rate.

Q21.. Is 7-15 years worth of plant-specific data necessary before CHECWORKS can be used reliably to recalibrate CHECWORKS to EPU conditions?

A21. (Hsu) No, it is not necessary to have 7-15 years plant-specific data to ensure that CHECWORKS can be used reliably. Currently, there are a lot of utilities with EPUs (Clinton 20% EPU, Dresden Units 2 & 3 17% EPU, and Quad Cities Units 1 & 2

17.8% EPU) that do not have 7-15 years of data. The answer above addressed the industry guidance referenced by NEC--Chockie Group International, "Aging Management and Life Extension in the US Nuclear Industry" (October 2006) (Exh. NEC-UW_13 at 38). That guidance does not suggest 7-15 years of FAC data is needed.

Q22. Can CHECWORKS be used effectively at Vermont Yankee during the period of extended operations?

A22. (Hsu) Yes, CHECWORKS can be used effectively at VY during the period of extended operation. Vermont Yankee will continue its FAC aging management program to perform additional inspections using CHECWORKS throughout the life of the plant. There are a lot of utilities with approved EPUs successfully using CHECWORKS, including, Clinton 20% EPU, Dresden Units 2 & 3 17% EPU, and Quad Cities Units 1 & 2 17.8% EPU.

Q23. Explain why Vermont Yankee can use CHECWORKS under EPU conditions if the plants supplying data for CHECKWORKS have not increased power by 20%.

A23. (Hsu) CHECWORKS was developed independent of power levels. To use CHECWORKS, the user must accurately input plant parameters. Vermont Yankee increased its output by 20%, from 1592 MWt to 1911 MWt. Dresden Units 2 & 3 increased their output by 17%, from 2527 MWt to 2957 MWt. Quad Cities Units 1 & 2 increased their output by 17.8%, from 2511 MWt to 2957 MWt. Clinton increased its output by 20%, from 2897 MWt to 3457 MWt. The original power levels for all of those plants were much greater than Vermont Yankees, and thus, their extended power uprate outputs are much greater than that of Vermont Yankee. All of these plant use CHECWORKS.

Q24. NEC claims that as a result of Vermont Yankee's EPU, which increased flow velocity, new locations of high corrosion are likely to develop that CHECWORKS as calibrated to pre-EPU conditions will be unable to predict. Is this correct?

A24. (Hsu) No, the most important part in using CHECWORKS is evaluating the information provided by the model and applying engineering judgment to select appropriate inspection locations. Vermont Yankee has addressed the impact of the EPU on FAC in the feedwater and steam related systems. Vermont Yankee addressed the impact of the EPU on plant components as stated in the letter BVY 04-008 Attachment 2 (ML040480640) (Staff Exh. 17). In addition, Section 2.1.6 of Safety Evaluation Report for Vermont Yankee's EPU (ML053010167) (Staff Exh. 14) stated that "The licensee has determined that an increase in the velocities in the main steamline and feedwater lines will cause proportional increases in FAC wear rate." Vermont Yankee multiples the velocity increase by the pre--EPU wear rate to get an EPU wear rate. Vermont Yankee has now performed inspection(s) to confirm FAC wear rates for EPU period. The inspections confirmed Vermont Yankee's predictions. Exhibit NEC-UW_11 at 43. Any additional inspection data can be used to further confirm FAC wear rate.

Q25. NEC claims that calibration of CHECWORKS is difficult because FAC is highly localized, may not be linear with time, and results from the interaction of many complex variables. Is this correct?

A25. (Hsu) Corrosion is not an exact science due to epistemic and aleatory uncertainty which cannot be eliminated. CHECWORKS is a tool to help identify which piping is most susceptible to FAC, monitor FAC, and mitigate FAC in advance of failure. CHECWORKS is not for calculating absolute values of actual wear. It is very difficult to calculate absolute wear and predict accurately. The purpose of this software is to provide reasonable assurance that structural integrity will be maintained between inspections.

Q26. Is using data from other plants sufficient to predict FAC at Vermont Yankee under EPU conditions? Why or why not.

A26. (Hsu) Vermont Yankee increased its power level by 20% from 1592 MWt to 1911 MWt, an increase of 319 MWts. While other plants have increased power by less than 20%, the increases in MWts produced are much greater because their original power levels were much greater. Dresden Units 2 & 3 increased power by 17% from 2527 MWt to 2957 MWt for an increase of 430 MWts. Quad Cities Units 1 & 2 increased power by 17.8% from 2511 MWt to 2957 MWt for an increase of 446 MWts. Clinton increased power by 20% from 2897 MWt to 3457 MWt for an increase of 560 MWts. The empirical wear formulation from these and other plants has been incorporated into CHECWORKS. It is therefore acceptable for VY to use CHECWORKS for ranking FAC susceptible locations at EPU conditions while keeping in mind, that once inspections have been performed and the results entered into CHECWORKS, CHECWORKS uses plant-specific inspection data and wear rates for its predictions.

Q27. Does CHECWORKS need to be continuously updated with plant-specific inspection data in order to effectively predict pipe wall thinning?

A27. (Hsu) As previously stated, only two cycles of inspection results are needed to use CHECWORKS to predict pipe-wall thinning. However, Vermont Yankee plans to continue inspecting FAC-susceptible piping and inputting the results into CHECWORKS for the life of the plant. The CHECWORKS model must be updated to reflect current plant-specific operating parameters in order to effectively predict FAC behavior. The CHECWORKS program (i.e. the software), like other commercial software, is periodically upgraded based on data supplied by the CHECWORKS users group and improvements in computer and imaging technology.

Q28. Would additional cycles of plant-specific inspection data be useful to calibrate/recalibrate CHECWORKS? If yes, explain how the data would be helpful.

A28. (Hsu) Additional inspection data is useful to confirm the predictions and/or to confirm the need to repair or replace components. Additional inspection data, however, would not be useful to recalibrate the program in an effort to determine absolute wear rates.

Q29. Has CHECWORKS been shown to handle large changes in plant parameters?

A29. (Hus) Yes, currently CHECWORKS is used successfully at Clinton (20% EPU (579 MWT)), Dresden Units 2 & 3 (17% EPU (430 MWT)), Quad Cities Units 1&2 (17.8% EPU (446 MWT)), and Vermont Yankee (20% EPU (319 MWT)).

Q30. Is CHECWORKS an effective tool to monitor and manage the aging effects of FAC?

A30. (Hsu) Yes, CHECWORKS is being used successfully by all US nuclear utilities, many US fossil plants, and utilities overseas. It is important to keep in mind that CHECWORKS just a tool to help the user selecte FAC-susceptible locations for inspection and monitoring. It provides reasonable assurance that structural integrity will be maintained between inspections, not that FAC will not occur or that repairs, including costly ones, will never be needed.

Q31. Does CHECWORKS need to be modified as a plant ages?

A31. (Hus) No, but the FAC aging management program is continued throughout the plant's life.

Q32. Do FAC incidents at other nuclear power plants call into question the predictive capability of CHECWORKS?

A32. (Hsu) CHECWORKS has to use actual wear from inspection(s) to perform its trend/predictions. In his first declaration (Exhibit 7 to NEC's May 26, 2006 Petition to Intervene), Dr. Hopenfeld listed FAC incidents at other nuclear plants. In paragraph 26 of that declaration Dr. Hopenfeld states that:

> "This list alone, however, is sufficient to demonstrate that CHECWORKS (developed in 1987) has not been successful in averting major catastrophes and costly outages."

The statement is not accurate for the following four reasons. (1) The 1986, feedwater pipe elbow rupture at Surry occurred before CHECWORKS was developed and therefore does not demonstrate that CHECKWORKS has been unsuccessful in averting problems. (2) The 1990 and 1993, feedwater ring and J-tube ruptures in San Onofre's steam generators do not demonstrate that CHECWORKS has not been successful in identifying FAC. As stated in NRC Information Notice 91-19 (IN 91-19) (Staff Exh. 20), the issue was identified during a routine outage inspection. Following the incident, the steam generator vendor, Combustion Engineering, issued an information bulletin recommending that its client utilities perform a baseline inspection during their refueling outage to detect wall thinning in the feedwater distribution system. There were no established base line inspections for the feedwater ring and the J-tubes in San Onofre's steam generator at the time of the events. Therefore, there was no actual wear data for CHECWORKS to trend/predict. Furthermore, the feedwater ring and J-tubes are located inside of steam generator and are managed by a plant's steam generator integrity program not its FAC program. Thus there is no way to justify the incidents as a failure of

CHECWORKS. (3) The 1997 extraction steam piping ruptured at the Fort Calhoun Station was not a failure of CHECWORKS. As discussed in NRC Information Notice 97-84 (Exh. NEC-JH_51), the cause of this FAC incident was incorrect operating data inputs, length of component service time, and line correction factor. One of the inputs in CHECKWORKS is the length of component service time. The actual wear occurred over the 2 years the component was actually in service rather than presumed 14 years in the CHECWORKS model. Therefore, the calculated line correction factor was biased and thus under-predicted the wear rates, resulting in the unpredicted pipe failure. This failure was the result of an input error and therefore does not evidence a failure of CHECWORKS to perform its trending/prediction function. (4) The 2004, condensate system piping rupture at the Mihama-3 was not a failure of CHECWORKS since Mihama did not use EPRI Guidelines or CHECWORKS. As discussed in NRC Information Notice 2006-08 (Staff Exh. 21), FAC is managed differently in Japan than in the US, where most licensees manage FAC by implementing the EPRI Guidelines described in NSCA-202L.

In short, these four events do no demonstrate that CHECWORKS has not been successful in managing FAC.

Q33. Has Vermont Yankee ever had an FAC-related pipe rupture?

A33. (Rowley) The Staff has no record of a FAC-related pipe rupture in the 3rd quarter of 2006 as NEC has stated. There is a record of a small leak in a six inch piping segment of the low pressure turbine gland seal, which was replaced in the spring outage of 2007.

Q34. For purposes of license renewal, is it sufficient for Entergy to "generally know" the piping locations at Vermont Yankee most susceptible to FAC?

A34. (Hsu) Yes, the detailed discussion can be found in BVY 04-008 Attachment 2 (ML040480640) (Staff Exh. 17). In Attachment 2 to BVY-04008, Vermont Yankee provided detailed discussion for those piping lines and systems where predicted wear rates would change due to changes in temperatures and velocities after EPU. The staff evaluated Vermont Yankee's FAC program after EPU and determined it to be acceptable.

Q35. Could FAC-susceptible locations develop without the ability of CHECWORKS to rank those locations?

A35. (Hsu) There are miles of piping in nuclear plants, making it impossible to inspect all of it. CHECWORKS helps identify which piping is most susceptible to FAC and is a way to set priorities. As described in BVY 04-008 Appendix E (ML040480640) (Staff Exh. 17), the criteria for selecting specific components for examination during a refueling outage include (1) CHECWORKS Predictive Models (2) Components Identified during previous inspections (3) Industry Experience Components (4) Susceptible piping not modeled by CHECWORKS (5) Plant specific experience and Engineering Judgment. The program also includes expansion of the scope when significant wall thinning is discovered in a component. CHECWORKS is not the only option for selection of FAC-susceptible locations. Vermont Yankee is not relying solely on CHECWORKS to predict susceptible locations and select locations for inspection. Vermont Yankee's use of these five criteria to identify susceptible locations and select examination locations provides assurance that susceptible locations will be identified and inspected.

Q36. Is CHECWORKS sufficient to predict FAC at Vermont Yankee during the period of extended operation?

A36. (Hsu) The UT inspection results are entered into CHECWORKS, which determines the actual wear rate and recalibrates itself. The actual wear is used to trend/predict by CHECWORKS. As long as all the operating parameters are correctly entered, CHECWORKS is sufficient to trend/predict throughout plant life. Also, as previously stated, Vermont Yankee is not relying solely on CHECWORKS to identify susceptible locations for inspection but has four additional criteria: components identified in pervious inspections, industry experience, susceptible piping not modeled by CHECWORKS, and engineering judgment.

Q37. Will Vermont Yankee have enough plant specific data prior to the period of extended operation to recalibrate CHECWORKS to EPU conditions during the period of extended operation?

A37. (Hsu) Yes, as mentioned above, in Section 2.1.6 of Safety Evaluation Report of VY EPU (ML060050028) (Staff Exh. 14) reported: "The licensee has determined that an increase in the velocities in the main steam line and feedwater lines will cause proportional increases in FAC wear rates" and the Staff agreed. On the basis of the above statement, Vermont Yankee needs only one inspection to confirm FAC ware rate for the EPU period for those components that have inspection data from the last outage. (If this was not the case, two continuous inspections are required to input data into CHECWORKS to determine the actual wear and recalibrate itself.) Vermont Yankee has conducted 63 inspections for pipe-wall thinning since the EPU. The licensee reported to the ACRS Subcommittee that the inspection results were satisfactory and consistent with analytical predictions that VY used in its modeling for FAC. Exh. NEC-UW_13 at 38. Additional inspection data can be used to confirm FAC wear rate and refine the model.

Q38. Will the data collected from the remaining scheduled outages prior to license renewal using Vermont Yankee's existing FAC program be sufficient to calibrate CHECWORKS to post-EPU conditions?

A38. (Hsu) Yes, Entergy stated that the number of piping inspections will be increased by 50% for the next three refueling outages. The first inspection has been completed and the results can be used to demonstrate its trend/prediction. Vermont Yankee reported to an ACRS Subcommittee that 63 inspections have been completed and all were satisfactory and consistent with analytical predictions that Vermont Yankee use in its modeling for FAC. Exh. NEC-UW_11 at 43. Vermont Yankee will continually use the model to pick the areas to inspect and feed data into CHECWORKS. The data from these inspections is entered into CHECWORKS, which determines the actual wear and recalibrate itself. It's an ongoing cycle, a living program.

Q39. Why did the Staff conclude that Vermont Yankee's FAC program, which includes CHECWORKS, is adequate to monitor and manage the plant piping due to FAC?

A39. The Staff concluded that Vermont Yankee's FAC program is adequate to address the plant FAC issues and its basis follows: (1) Vermont Yankee's program is consistent with Staff-endorsed GALL Report recommendations; (2) Vermont Yankee's Commitment No. 51, as stated in SER for the LRA, addresses staff's concern for license renewal applicants with approved EPUs; and (3) Vermont Yankee's detailed FAC discussion, as shown in BVY 04-008 (Staff Exh. 17), adequately addressed the impact of EPU on all susceptible systems.

On these bases the Staff concluded that Vermont Yankee/Entergy demonstrated that the effects of aging due to FAC on plant piping will be adequately managed so that the intended functions will be managed consistent with the CLB for the period of extended operation, as required by 10 C.F.R. § 54.21(a)(3).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.	))	Docket No. 50-271-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF KAIHWA R. HSU

I, Kaihwa R. Hsu, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Kaihwa R. Hsu

KAIHWA R. HSU

Executed at Rockville, MD
this 13th day of May, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket No. 50-271-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF JONATHAN G. ROWLEY

I, Jonathan G. Rowley, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Jonathan Rowley
JONATHAN G. ROWLEY

Executed at Rockville, MD
this 13th day of May, 2008

June 2, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket No. 50-271-LR
	)	ASLBP No. 06-849-03-LR
(Vermont Yankee Nuclear Power Station)	)	

NRC STAFF REBUTTAL TESTIMONY OF
KAIHWA R. HSU CONCERNING NEC CONTENTION 4

Q1. Please state your name, occupation, and by whom you are employed.

A1. My name is Kaihwa R. Hsu ("Hsu"). I am employed by the US Nuclear Regulatory Commission ("NRC") as a senior mechanical engineer in the Engineering Division in the Office of New Reactors. Previously I was employed as a materials engineer in the office of Nuclear Reactor Regulation Division of License Renewal. A statement of my professional qualifications was attached to the staff's "Affidavit of Kaihwa R. Hsu, Jonathan G. Rowley, and Thomas G. Scarbrough Concerning NEC Contention 3 (Steam Dryer)," filed May 13, 2008.

Q2. What is the purpose of this testimony?

A2. The purpose of this rebuttal testimony is to address the pre-filed written testimony and exhibits of Dr. Hausler, Mr. Witte, and Dr. Hopenfeld regarding New England Coalition, Inc.'s ("NEC") Contention 4, which were submitted on behalf of NEC on April 28, 2008.

Q3. In his "Discussion of the Empirical Modeling of Flow-Induced Localized Corrosion of Steel under High Shear Stress" ("NEC-RH_03"), Dr. Hausler expressed his concern for uncertainties in the methodology of ultrasonic thickness ("UT") measurements due to: 1) "[t]he inherent variability of the instrument with which the measurements are being made"; and 2) "[t]he inherent difficulty of placing the handheld UT probe at exactly the same location for repeat measurements one-and-a-half to two years apart." Exhibit NEC-RH_03 at Appx. A. Do you agree that these are areas of concern?

A3. No, I do not agree that these are areas of concern for UT measurements. First, inherent variability of the instrument is not a concern because in the nuclear industry, standards require that UT instruments be properly calibrated and UT technicians be trained to perform UT measurements. In addition, information regarding the accuracy of handheld UT probes is provided to the user by the manufacturer. Recent UT wall thickness technology has demonstrated that UT measurements are capable of attaining measurement accuracy for a high frequency UT transducer of +/- 0.01mm, which is significantly lower than +/- 1% to 2% of wall thickness claimed by Dr. Hausler, *see id.*

Second, any inherent difficulty in placing the probe in the same location for temporally separate repeat measurements has been eliminated because the plant has painted a permanent grid on the outside surface of the pipes. This permanent grid provides assurance that the probe will be placed in the same location for repeat measurements.

Q4. In NEC-RH_03, Dr. Hausler concluded "that the absolute minimum number of thickness measurements required for reasonably accurate prediction of failure is three, if an assessment of the confidence limits of the resulting trend is to be made." *Id.* at Appx. A. Do you agree with this statement?

A4. The Staff agrees that three measurements are required. In order for the aging management program to be consistent with GALL Report's recommendation, "limited baseline inspections to determine the extent of thinning at these locations" can be accomplished by performing two measurements, and "follow-up inspections to confirm the predictions" can be accomplished by performing a third measurement. NRC Staff Initial Statement of Position on

NEC contentions 2A, 2B, 3, and 4 (May 13, 2008), Exhibit 7 at XI M-61.

Although Dr. Hausler stated "that at least two measurements are needed to determine the rate of deterioration," he concludes that a minimum of three measurements are required for a reasonably accurate prediction of failure, if an assessment of the confidence limits is required. Exhibit NEC-RH_03 at Appx. A. This notion is based on his concern of uncertainty in the methodology of measurement. As described above in A3, the uncertainty has been essentially eliminated due to the accuracy of the measuring equipment. Therefore, the uncertainty concerns are not valid.

Q5. Mr. Witte, in his report regarding proposed aging management programs for flow-accelerated corrosion ("FAC"), stated that a concern "regarding deficiencies in implementation of the program brings into question the results of FAC inspection during RFO 25 and RFO 26 . . . ." Exhibit NEC-UW_03 at 2. Do you agree with this statement?

A5. No, I do not agree with this statement. There is no basis to question the results of the FAC inspection during RFO 25 and RFO 26. The results of these FAC inspections are actual UT wall thickness measurements that are independent of the CHECWORKS software or model update. CHECWORKS is used to manage and evaluate the actual wall thickness data to help trend/predict pipe failure due to FAC.

Q6. In his report regarding proposed aging management programs for FAC, Mr. Witte stated that

> [w]ith the exception of VY's [Vermont Yankee's] strength in reactively replacing piping or components with FAC-resistant material during repairs or maintenance, the program itself was not effective as a predictive modeling tool. Simply stated, once something ruptured or was found to be outside of its design margin, it was replaced in a reactive management approach. Proactive management of the program to *predict failures* has been inadequate in the FAC Program . . . .

Exhibit NEC-UW_03 at 7 (emphasis in original). Do you agree with this statement?

A6. No, I do not agree with this statement. The Staff's position is that a FAC program that performs inspections successfully, identifies critical FAC-susceptible components, and allows for replacement of piping and components with FAC-resistant material to prevent failure due to FAC, is effective.

Q7. In "Review of License Renewal Application for Vermont Yankee Nuclear Power Station: Program for Management of Flow-Accelerated Corrosion," Dr. Hopenfeld stated that

> [a]ccording to NUREG/CR-6936, *Probabilities of Failure and Uncertainty Estimate Information for Passive Components – a Literature Review* (May 2007) at Table 5.15, there were 250 through-wall pipe failures from FAC in BWRs and PWRs between 1988 and 2005, compared to 183 failures that occurred between 1976 and 1987. On a yearly basis, this represents a reduction of 2 failures per year during 1988-2005 period compared to the previous period, disregarding the number of reactors and their age. Since the CCC codes were introduced in 1987, one could attribute the 10% reduction to the CCC codes.

Exhibit NEC-JH_36 at 9. Do you agree with this statement?

A7. No, I do not agree with this statement. Dr. Hopenfeld's conclusions and use of the data is incorrect. NUREG/CR-6936 does not support his testimony.

Dr. Hopenfeld relies on data reported in NUREG/CR-6936, which was extracted from Appendix D of NUREG-1829 (Exhibit A, *Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process*, (Apr. 2008)). However, the service data extracted from NUREG-1829, as recorded in PIPExp. (a proprietary database for pipe failure experience), included applicable **worldwide** service experience, not just US nuclear industry data.

NUREG-1829 states that

> *D.3.2 2 FW Piping Service Experience* - Figures D.9 and D.10 summarize the service experience with FW piping. With respect to plant designed by General Electric, the Code Class I portion of BWR carbon steel feedwater piping has performed well in the field. There are no reported leaks in medium-or large diameter RCPB piping. Foreign plants have experienced (and in some cases, continue to experience) thermal fatigue damage due to thermal mixing and stratification. In fact, 80% of the degradation of the RCPB portions of FW piping has occurred in foreign plants with a piping system design that differs from that of U.S. BWR plants.

> The U.S. service experience includes a few instances of non-through wall cracking of FW nozzle-to-safe-end (bimetallic) welds. The root cause of the cracking is attributed to weld defects from original construction. As documented in Information Notice 92-35 [D. 19], Susquehanna Unit I has experienced flow-accelerated corrosion damage about 250 mm (10 inches) from a weld connecting NPS12 piping to a 20-inch by 12-inch reducing tee. **There have been no reported flaws in any U.S. plant beyond T = 15 years of operation.**

Id. at D-22 (emphasis added). Contrary to Dr. Hopenfeld's statement, this information indicates that the frequency of FAC related events at US nuclear plants has declined significantly and there have been no FAC-related injuries at US nuclear plants since improved FAC programs (e.g., EPRI guidelines, CHECWORKS) have been used in the US nuclear industry.

Q8. Mr. Witte stated in his report regarding proposed aging management programs for FAC that "VY is the first plant modified to achieve Constant Pressure Power Up-rate to 120% power and only one other plant out of the fleet of 104 was licensed to 120% increase in power in one step. Given the uniqueness of the design of VY's power up-rate, CHECWORKS has little industry benchmarking data, and is of marginal use." Exhibit NEC-UW_03 at 8. Is this a correct statement?

A8. No, this is not a correct statement. There is enough industry data regarding BWR extended uprates to demonstrate CHECWORKS benchmarking. For example, Dresden Units 2 & 3 extended 17% of their power from 2527 MWt to 2957 MWt; Quad Cities Units 1 & 2 extended 17.8% of their power from 2511 MWt to 2957 MWt; and Clinton extended 20% of its power from 2894 MWt to 3473 MWt. Exhibit B, *Approved Application for Power Uprates,* http://www.nrc.gov/reactors/operating/licensing/power-uprates/approved-applications.html (last visited June 2, 2008). In comparison, VY extended 20% of its power from 1593 MWt to 1912 MWt. *Id.* The original power levels of Dresden, Quad Cities, and Clinton are much greater than VY's extended power level. The Staff's position is that the above plants are comparable to VY, and therefore, there is enough industry data to demonstrate benchmarking for extended power uprates.

CHECWORKS was designed for FAC prediction at the power levels at which the plant is being operated. The program does not recognize whether the power levels have been uprated or remain at lower levels, the use of the program remains unchanged. Data from plants that have a power level much higher than VY's extended power level have already been considered in the CHECWORKS development. Therefore, it is not accurate to say CHECWORKS only has a marginal use.

Q9. In "Review of License Renewal Application for Vermont Yankee Nuclear Power Station," Dr. Hopenfeld asserts that "[t]o account for local turbulence . . . , the grid should be kept to below 1" x 1" inch." Exhibit NEC-JH_36 at 15. Do you agree with this statement?

A9. No, I do not agree with this statement. If the grid is kept to below 1 inch by 1 inch, then inspection of more than 6,000 points for a 30 inch diameter, long radius elbow would be required. This is not necessary or feasible. The FAC failure cases have demonstrated that a large bore pipe failure occurs over much more than a 1 inch x 1 inch area.

Q10. Dr. Hopenfeld has previously stated that "[i]t is important to realize that wall thinning rate from FAC is not necessarily constant with time, and therefore a considerable number of cycles are needed to establish the FAC rate on a given component at a particular plant." Exhibit C, Petition for Leave to Intervene, Request for Hearing and Contentions (May 26, 2006) at Exhibit 7 ¶ 24 (ADAMS ML061640032). In contrast, NEC's pre-filed exhibit, NEC-JH_37, indicates that there is a linear relationship between FAC degradation and time. Do you agree with Dr. Hopenfeld's previous statement or with the information submitted in NEC Exhibit NEC-JH_37?

A10. I agree with the information in NEC-JH_37. The laboratory data and plant data shown in Figures 4 and 5 of NEC-JH_37 clearly demonstrate that the FAC degradation is linear with time. This is the basis for trending/predicting FAC failure date. This algorithm has been adopted for all plants, including those plants not using CHECWORKS.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket No. 50-271-LR
	)	ASLBP No. 06-849-03-LR
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF KAIHWA R. HSU

I, Kaihwa R. Hsu, do hereby declare under penalty of perjury that my statements in the foregoing testimony are true and correct to the best of my knowledge and belief.

Kaihwa R. Hsu

KAIHWA R. HSU

Executed at Rockville, MD
this 2nd day of June, 2008

MR. ROTH: No objections, Your Honor. But just going back, setting backwards a little bit, there was corrected exhibits that were handed out by Entergy. I didn't get a copy of those both with respect to the steam dryer and Exhibit 8.

JUDGE KARLIN: All right. Mr. Diaz, could you get that to Mr. Roth please?

MR. TRAVIESO-DIAZ: Yes.

JUDGE KARLIN: Did you have something, Mr. Subin?

MR. SUBIN: Yes, I also wanted to admit the corresponding exhibits.

JUDGE KARLIN: Yes, certainly.

MR. SUBIN: Sixteen, 17, 18, 20, 21, A, B, C and Exhibits 1 and 19 have already been admitted.

JUDGE KARLIN: All right.

MR. SUBIN: I move to have those admitted.

(Whereupon, the documents referred to were marked as NRC Staff Exhibits 17-21 and A-C for identification.)

JUDGE KARLIN: So have all of them already been admitted?

MR. SUBIN: No, just the last two that I mentioned earlier.

JUDGE KARLIN: But the others you are moving for admission?

MR. SUBIN: Right. Correct.

JUDGE KARLIN: Any objections?

(No verbal responses.)

Hearing none, they're admitted.

(The documents referred to having been previously marked for identification as NRC Staff Exhibits 17-21 and A-C were received in evidence.)

Is that all, Mr. Subin?

MR. SUBIN: Yes, that's all.

JUDGE KARLIN: Ms. Tyler.

MS. TYLER: The direct and rebuttal testimony of Joram Hopenfeld has already been admitted. I now move to admit the exhibits referenced in that testimony which are exhibit NEC JH-36 through exhibit NEC JH-53 and Exhibit NEC JH70 through NEC JH72.

(Whereupon, the documents referred to were marked as NEC Exhibit JH36-JH53 and JH70-JH72 for identification.)

Now directing questions to Dr. Rudolf

Hausler.

JUDGE KARLIN: Are there any new exhibits associated with Dr. Hopenfeld's testimony?

MS. TYLER: NEC would like to admit all the exhibits associated with his testimony.

JUDGE KARLIN: I'm sorry. Are there any new exhibits associated with his Contention 4 testimony --

MS. TYLER: I just mentioned --

JUDGE KARLIN: -- that haven't already been admitted?

MS. TYLER: I just did mean to admit those.

JUDGE KARLIN: Okay. Any objections?

(No verbal response.)

No. Then they're admitted.

(The documents referred to having been previously marked for identification as NRC Exhibits JH36-JH53 and JH70-JH72, was received in evidence.)

Yes. Okay. Now proceed.

MS. TYLER: Okay. Directing questions to Dr. Rudolf Hausler, Dr. Hausler, do you have in front of you the pre-filed direct testimony of Dr. Rudolf Hausler regarding NEC's Contention 4 and the pre-filed rebuttal testimony of Dr. Rudolf Hausler regarding NEC's Contention 4?

DR. HAUSLER: I do.

MS. TYLER: Did you prepare this testimony for submission in this proceeding?

DR. HAUSLER: I'm sorry -- A little difficulty hearing.

MS. TYLER: Did you prepare this testimony for submission in this proceeding?

DR. HAUSLER: Yes.

MS. TYLER: Do you have any corrections to make to the testimony at this time?

DR. HAUSLER: No ma'am. Not at this time.

MS. TYLER: Do you adopt this testimony as your sworn testimony in this proceeding?

DR. HAUSLER: I do.

MS. TYLER: I move to admit Dr. Rudolf Hausler's testimony.

(Whereupon, the document referred to was marked as NEC Exhibit for identification.)

JUDGE KARLIN: All right. Any objections?

(No verbal response.)

Hearing none, it is admitted.

(The document referred to having been previously marked for identification as NEC Exhibit, was received in evidence.)

NEC-RH_01

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

Alex S. Karlin, Chairman
Dr. Richard E. Wardwell
Dr. William H. Reed

In the Matter of	
ENTERGY NUCLEAR VERMONT YANKEE, LLC, and ENTERGY NUCLEAR OPERATIONS, INC.	Docket No. 50-271-LR ASLBP No. 06-849-03-LR
(Vermont Yankee Nuclear Power Station)	June 20, 2006

PRE-FILED DIRECT TESTIMONY OF Dr. RUDOLF HAUSLER REGARDING NEC CONTENTION 4

Q1. Please state your name and address.

A1. My name is Dr. Rudolf Hausler. My business address is 8081 Diane Drive, Kaufman, Texas, 75142.

Q2. What is your educational and professional background?

A2. I have received the following degrees at the Swiss Federal Institute of Technology in Zurich, Switzerland: BS and MS in Chemical Process Technology and Ph.D in Chemical Engineering. I am an expert in corrosion prevention, chemical inhibition, material selection, failure analysis, and trouble-shooting.

During a professional career spanning more than 35 years, I have: consulted for various organizations worldwide regarding nuclear safety, including the safety of spent fuel storage casks; consulted for major oil companies and engineering companies throughout the world on selection, testing, and application of oil field chemicals, with a primary focus on corrosion inhibitors; and developed a flow-through corrosion testing facility to meet industry-specific needs for Mobil Oil, and custom corrosion inhibitors for Petrolite Corporation, with the specific focus on inhibition under conditions of high and ultra-high flow rates in multiphase flow.

My experience is further described on my Curriculum Vitae filed with this testimony as Exhibit NEC-RH_02.

Q3. Can you cite specific examples of recognition by the scientific community?

A3. I received the 2003 Fellow Award, as well as the 1990 Technical Achievement Award, from the National Association of Corrosion Engineers (NACE). I am a NACE-certified Corrosion Specialist. I currently hold 17 patents, have published 58 papers, and have given more than 100 technical presentations about a variant of topics, including corrosion management, over the course of my career. I am a registered Professional Corrosion Engineer with the California Board of Professional Engineers and Land Surveyors.

Q4. What is your understanding of the issues presented by New England Coalition's (NEC's) Contention 4 in this proceeding?

A4. NEC's Contention 4 concerns the program the license renewal Applicant has proposed to manage flow-accelerated corrosion (FAC) during the period of extended operations. The Applicant proposes to the use the CHECWORKS model in this program as a tool to determine the scope and frequency of its FAC inspection regime. NEC maintains that CHECWORKS must be recalibrated because a twenty percent increase in the Vermont Yankee plant's operating power implemented in 2006 significantly altered relevant plant parameters. NEC further maintains that recalibration of the model cannot be accomplished within the timeframe prior to the beginning of extended operation begins.

Q5. Did you prepare a report of your evaluation of issues relevant to NEC's Contention 4?

A5. Yes, I did. This report is filed with this testimony as Exhibit NEC-RH_03. This testimony and my report provide, to the best of my knowledge, true and accurate statements of my conclusions regarding the issues relevant to NEC's Contention 4 that I have addressed.

Q6. Please briefly summarize your conclusions as stated in your report filed with this testimony as Exhibit NEC-RH_03, and the bases for your conclusions.

A6. I agree that it will be necessary to recalibrate CHECWORKS, an empirical model, following the significant increase in flow velocity that would result from the twenty percent power uprate. It would be erroneous for the Applicant to rely on inspection grids established prior to the power uprate.

In support of these conclusions, my report provides an overview of the parameter field which must be considered and controlled if one is attempting to model iron corrosion for the purpose of predicting failure under certain defined conditions; and summarizes the major correlations that have been shown to govern the kinetics of iron oxide dissolution/erosion, i.e. what has been called "flow-assisted corrosion" (FAC). My report explains that the location of FAC will change as the flow rate changes. It further discusses why it is very difficult to predict a) where the localized corrosion will occur; b) how fast it will take place, and c) where it will be moved to as the flow rate changes.

Finally, it is my professional opinion that 12-15 years is a reasonable estimate of the time necessary to recalibrate the CHECWORKS model. In support of this conclusion, Appendix A to my report includes a statistical evaluation, the details of which are explained therein.

Q7. Does this conclude your testimony regarding NEC's Contention 4 at this time?

A7. Yes it does.

I declare under penalty of perjury that the foregoing is true and correct.

Rudolf H. Hausler

Rudolf Hausler, PhD

At Kaufman, Texas, this 22 day of April, 2008 personally appeared Rudolf Hausler, and having subscribed his name acknowledges his signature to be his free act and deed.

Before me:

Jennifer Juliana Perez

Notary Public

My Commission Expires August 22, 2011

JENNIFER JULIANA PEREZ
Notary Public
STATE OF TEXAS
My Comm. Exp. August 22, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

Alex S. Karlin, Chairman
Dr. Richard E. Wardwell
Dr. William H. Reed

In the Matter of

ENTERGY NUCLEAR VERMONT YANKEE, LLC, and
ENTERGY NUCLEAR OPERATIONS, INC.

(Vermont Yankee Nuclear Power Station)

Docket No. 50-271-LR

ASLBP No. 06-849-03-LR

June 20, 2006

PRE-FILED REBUTTAL TESTIMONY OF DR. RUDOLF HAUSLER REGARDING NEC CONTENTION 4

Q1. Please state your name.

A1. My name is Rudolf Hausler.

Q2. Have you previously provided testimony in this proceeding?

A2. Yes, I provided direct testimony in support of New England Coalition, Inc.'s (NEC) Initial Statement of Position, filed April 28, 2008.

Q3. Have you reviewed the initial statements of position, direct testimony and exhibits filed by Entergy and the NRC Staff concerning NEC's Contention 4?

A3. Yes. I have reviewed the section of Entergy's Initial Statement of Position on New England Coalition Contentions (May 13, 2008) that concerns NEC's Contention 4 and all Exhibits thereto, and the Joint Declaration of Jeffrey S. Horowitz and James C. Fitzpatrick on NEC Contention 4 – Flow-Accelerated Corrosion (May 12, 2008). I have also reviewed the section of the NRC Staff Initial Statement of Position on NEC Contentions 2A, 2B, 3, and 4 that concerns NEC's Contention 4 and all exhibits thereto, and the Affidavit of Kaihwa R. Hsu and Jonathan G. Rowley Concerning NEC Contention 4 (Flow-Accelerated Corrosion) (May 13, 2008).

Q5. Did you prepare a report of your evaluation of the Entergy and NRC Staff Initial Statements of Position and direct testimony on NEC's Contention 4?

A5. Yes, I did. This report is filed with this rebuttal testimony as Exhibit NEC-RH_05.

Q6. Please briefly summarize your conclusions as stated in your report filed with this testimony as Exhibit NEC-RH_05, and the bases for your conclusions.

A6. Entergy witness Dr. Horowitz has testified that it is not necessary to recalibrate or "benchmark" the Checworks model with plant inspection data following a twenty percent power uprate. Joint Declaration of Jeffrey S. Horowitz and James C. Fitzpatrick on NEC Contention 4 – Flow-Accelerated Corrosion at A33, 34. Rather, Dr. Horowitz contends that the only update to the Checworks model that is necessary following a twenty percent power uprate is the input of new values for flow rate and temperature into the model. Horowitz at A33, 34. Dr. Horowitz bases these assertions on his view that "[flow-accelerated corrosion (FAC)] wear rates vary roughly with velocity and do not increase with velocity in [a] non-linear (exponential) manner. . . .", Horowitz at A49, and his belief that the Checworks model can accurately predict any variations in FAC rates related to geometric features. Dr. Horowitz contends that the Checworks model accounts for any localized variations in FAC associated with geometric features through the use of " 'geometric factors' to relate the maximum degradation occurring in a component, such as an elbow, to the degradation predicted to occur in a straight pipe." Horowitz at A47, 48.

As explained in detail in my report, Exhibit NEC-RH_05, I agree that the rate of FAC generally varies almost linearly with fluid velocity; however, this linear relationship transitions to an exponential one as the local turbulence becomes such that erosional features become manifest. Whether such transition actually occurs when flow velocity increases following a power uprate must be determined experimentally. I do not agree that the Checworks model, or any model, can fully account for variations in the rate of FAC due to geometric features and discontinuities. Some things cannot be specified. For example, the internal residual weld bead from the root pass may be 1/8 inch high in one case, and ¼ inch high in another case. The upstream and downstream turbulence surrounding the weld bead will be more severe in the latter case, and a power uprate may disproportionately affect the flow over the larger bead.

Dr. Horowitz defines FAC as corrosion in proportion to the flow rate, and excludes from the definition of FAC the more severe forms of localized corrosion – erosion-corrosion, impingement and cavitation. *See,* Horowitz at A46. This definition of FAC is entirely arbitrary. Erosion-corrosion, impingement and cavitation are extensions of FAC as the local flow intensity due to turbulence increases. The transition from one to the others is continuous and difficult to identify. If Checworks is unable to predict these more severe forms of localized corrosion related to high flow rates, which can particularly occur after a power uprate, then this is a serious shortcoming of the model and its application.

The accuracy of Checworks has been said to be within +/- 50%. This statement is based on an erroneous interpretation of the graphic representation of predicted vs. measured wear. Actually, the accuracy is within a factor of 2 – the measured wear rates range from twice the prediction to half the prediction. A factor-of-two difference between measured and predicted corrosion [or corrosion rate] can be quite significant with respect to selecting a particular item (line) for inspection during a refueling outage. Indeed, the "EPRI Checworks Wear Rate

Analysis Results for Cycle 22B," Exhibit E-4-29, shows that the time predicted to reach the critical minimum wall thickness in a majority of cases is many years *negative*. This means that the item should have failed a long time ago. The remaining time to failure might just as readily be grossly overestimated. But one will never know unless the proper inspections are performed and the model is recalibrated.

Q7. Does this conclude your rebuttal testimony regarding NEC's Contention 4 at this time?

A7. Yes.

I declare under penalty of perjury that the foregoing is true and correct.

Rudolf H. Hausler

Rudolf Hausler, PhD

At Kaufman, Texas, this 28 day of May, 2008 personally appeared Rudolf Hausler, and having subscribed his name acknowledges his signature to be his free act and deed.

Before me:

Jennifer Juliana Perez

Notary Public

My Commission Expires August 22, 2011

JENNIFER JULIANA PEREZ
Notary Public
STATE OF TEXAS
My Comm. Exp. August 22, 2011

MS. TYLER: I also move to admit the exhibits referenced in that testimony which are exhibits NEC RH02 through NEC RH05.

(Whereupon, the documents referred to were marked as NEC Exhibit RH02-RH05 for identification.)

JUDGE KARLIN: Any objections?

(No verbal response.)

Hearing none, they're admitted.

(The documents referred to having been previously marked for identification as NEC Exhibits RH02-RH05, were received in evidence.)

MS. TYLER: Directing questions now to Ulrich Witte, Mr. Witte, do you have before you the pre-filed direct testimony of Ulrich Witte regarding NEC Contention 4 and the pre-filed rebuttal testimony of Ulrich Witte regarding NEC Contention 4?

MR. WITTE: Yes, I do.

MS. TYLER: And did you prepare this testimony for submission in this proceeding?

MR. WITTE: Yes, I did.

MS. TYLER: Do you have any corrections to make to it at this time?

MR. WITTE: No.

MS. TYLER: Do you adopt this testimony as your sworn testimony in this proceeding?

MR. WITTE: Yes, I did.

MS. TYLER: I move to admit Mr. Witte's testimony for the record.

(Whereupon, the document referred to was marked as NEC Exhibit for identification.)

JUDGE KARLIN: Any objections?

(No verbal response.)

Hearing none, it is admitted.

(The document referred to having been previously marked for identification as NEC Exhibit, was received in evidence.)

NEC-UW_01

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

Alex S. Karlin, Chairman
Dr. Richard E. Wardwell
Dr. William H. Reed

In the Matter of

ENTERGY NUCLEAR VERMONT YANKEE, LLC, and ENTERGY NUCLEAR OPERATIONS, INC.

(Vermont Yankee Nuclear Power Station)

Docket No. 50-271-LR

ASLBP No. 06-849-03-LR

PRE-FILED DIRECT TESTIMONY OF ULRICH WITTE REGARDING NEC CONTENTION 4

Q1. Please state your name and address.

A1. My name is Ulrich Witte. I reside on 71 Edgewood Way, Westville, Connecticut, 06515.

Q2. What is your educational and professional background?

A2. I obtained a BA in physics from the University of California, Berkeley in 1983. I have over twenty-six years of professional experience in engineering, licensing, and regulatory compliance of commercial nuclear facilities. I have considerable experience and expertise in the areas of configuration management, engineering design change controls, and licensing basis reconstitution. I have authored or contributed to two EPRI documents in the areas of finite element analysis, and engineering design control optimization programs. I have chaired the development of industry guidelines endorsed by the American National Standards Institute regarding configuration management programs for domestic nuclear power plants. My 26 years of experience has generally focused on assisting nuclear plant owners in reestablishing fidelity of the licensing and design bases with the current plant design configuration, and with actual plant operations. In short, my expertise is in assisting problematic plants where the regulator found reason to require the owner to reestablish competence in safely operating the facility in accordance with regulatory requirements. My experience is further detailed on my curriculum vitae filed with this testimony as Exhibit NEC-UW_02.

Q3. What is your understanding on NEC Contention 4 in this proceeding?

A3. NEC Contention 4 asserts that Entergy's plan for managing flow-accelerated corrosion (FAC) in plant piping fails to meet the requirements of 10 C.F.R. § 54.21(a)(3), *i.e.*, "fails to demonstrate that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB during the period of extended operations."

Q4. Did you prepare a report regarding this contention?

A4. Yes I did. My report is filed with this testimony as Exhibit NEC-UW_03. This testimony and my report provide, to the best of my knowledge, true and accurate statements of the facts and my conclusions regarding the issues relevant to NEC's Contention 4.

Q5. What materials did you review in support of your report and testimony?

A5. I reviewed the implemented FAC program and FAC inspection program, other inspection programs that Entergy has in place, and records and histories of these inspections. I also reviewed industry-wide standards for FAC programs, NRC data, information and reports, the CHECWORKS program and Entergy's commitments to upgrade the CHECWORKS model to EPU design conditions, inspection reports, EPU parameters, Plant Quality Assurance audits, Condition Reports, Corrective Actions, NRC regulations, EPRI review of the VY plant, Cornerstone Rollup, examples from other plants, and Entergy's application and the record (including reports, proposed programs, and testimony to the NRC Advisory Committee on Reactor Safeguards Subcommittee on Plant License Renewal) provided by Entergy or others in support of its application, including pipe wall thinning structural evaluation.

Further materials that I reviewed are specified in my attached report.

These are materials that are regularly used by experts in my field to assess aging management programs and flow-accelerated corrosion. I applied these materials in a standard manner that is routine with experts in this field.

Q6. Were these materials sufficient to allow you to form opinions and draw conclusions using your expertise?

A6. Yes, I had sufficient information to formulate the assessment stated in my report and maintain standards that are widely accepted by experts in this field. The Applicant did not, however, produce complete information to NEC regarding its methodology. My report notes where the Applicant's materials fail to provide sufficient information. As I have explained in my report, the information the Applicant produced is insufficient to validate its aging management program.

Q7. Please summarize your conclusions.

A7. In summary, I reached two conclusions:

First, the data collected under ~~the current~~ VYNPS FAC program ~~during the~~ post-EPU refueling outages scheduled ~~prior~~ to the expiration of the current VYNPS license is ~~insufficient to benchmark~~ CHECWORKS to VYNPS's post-EPU conditions. The Applicant states without ambiguity that the present program is sufficient not just for current operations and maintenance of the plant, but for the license renewal period as well. The record of a historical regulatory compliant program indicates otherwise.

~~Second, the current~~ VYNPS FAC program does not ~~appropriately~~ implement industry ~~guidance, and~~ does constitute an adequate aging management ~~plan with~~ respect to FAC.

More specifically, my conclusions are:

- Contrary to EPRI recommendations, from 1999-2006, Entergy apparently failed to update the CHECWORKS model in use at VYNPS with plant inspection data or information concerning plant modifications. This ~~lengthy lapse~~ may have significantly ~~weakened~~ the trending and ~~predictive~~ capability of the software, both during the ~~lapse~~ period and presently. The update to incorporate EPU design data appears to still be in progress as of February 2008.

- Contrary to EPRI recommendations, the VYNPS FAC program apparently used an outdated version of the CHECWORKS software during the years 2000-2006.

- In 2005, the CHECWORKS model predicted wall thinning close to or exceeding acceptable code limits at several locations, but Entergy apparently produced no Condition Reports addressing these imminent potential pipe ruptures, or at least has not produced such reports to NEC in this proceeding.

- Numerous internal Entergy reports label the VYNPS FAC program unsatisfactory. The program was deemed unsatisfactory in the 2004, and the 2006 cornerstone report expressed concern about the program and specifically the continued slow progress in updating the CHECWORKS model.

- An FAC-related pipe rupture appears to have occurred during the third quarter of 2006.

- The 2006 refueling outage FAC inspection scope, planning, documentation and procedural analysis all appear to have been performed under a superseded program document, potentially invalidating the pre-EPU baseline for use of CHECWORKS.

- ~~Entergy apparently reduced the number of FAC inspection data points by fifty percent (50%) between the 2005 refueling outage and the 2006 refueling outage, in violation of its commitment to *increase* inspection data points by fifty percent (50%).~~

Further detail and supporting information is in my attached report.

I declare pursuant to 28 U.S.C. § 1746 under penalty of perjury that the foregoing is true and correct.

Executed on April ___, 2008

____
Ulrich Witte

I declare under penalty of perjury that the foregoing is true and correct.

Ulrich Witte

At Westville, Connecticut, this 23rd day of April, 2008 personally appeared Ulrich Witte, and having subscribed his name acknowledges his signature to be his free act and deed.

Before me: Danette Broadhurst

Notary Public

My Commission Expires 8-31-2011

UNITED STATES
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC and ENTERGY NUCLEAR OPERATIONS, INC.	))	Docket No. 50-271-LR ASLB No. 06-849-03-LR
	)	
Vermont Yankee Nuclear Power Station	)	

PRE-FILED REBUTTAL TESTIMONY OF ULRICH WITTE REGARDING NEW ENGLAND COALITION, INC.'S CONTENTIONS 2A, 2B AND 4

Q1. Please state your name.

A1. My name is Ulrich Witte.

Q2. Have you previously provided testimony in this proceeding?

A2. Yes. I provided direct testimony in support of New England Coalition, Inc.'s (NEC) Initial Statement of Position, filed April 28, 2008.

Q3. Have you reviewed the initial statements of position, direct testimony and exhibits concerning NEC's Contentions 2A and 2B filed by Entergy and the NRC Staff?

A3. Yes. I have reviewed Entergy's Initial Statement of Position on New England Coalition Contentions (May 13, 2008), and the Joint Declaration of James C. Fitzpatrick and Gary L. Stevens on NEC Contention 2A/2B – Environmentally-Assisted Fatigue (May 12, 2008) and exhibits thereto. I have also reviewed the NRC Staff Initial Statement of Position on NEC Contentions 2A, 2B, 3, and 4, the Affidavit of John R. Fair

Concerning NEC Contentions 2A & 2B (Metal Fatigue) (May 13, 2008) and exhibits thereto, the Affidavit of Kenneth Chang Concerning NEC Contentions 2A & 2B (Metal Fatigue) (May 12, 2008) and exhibits thereto, and the revised Affidavit of Dr. Chang provided on May 22, 2008.

I. NEC's Contentions 2A and 2B – Environmental Assisted Metal Fatigue Analysis

Q4. Please describe your qualifications to provide testimony concerning NEC's Contentions 2A and 2B.

A4. I have extensive experience in original stress analysis in qualifying Class 1 and Class 2 pipe and components, and applicable ASME codes as well as ANSI B31.1 codes, in particular in the design, analysis, construction, and qualification of Class 1 and 2 systems within the domestic nuclear industry. This experience includes, for example, original stress analysis for McGuire, Catawba, and V.C. Summers Power Plants. In addition, I have performed non-linear finite element analysis for a number of components and I am familiar with Swanson's computer algorithms such as ANSYS., RELAP, and other commercial analytical computer programs. Under contract to EPRI, I conducted detailed correlation studies of non-linear finite element analysis code predictions against actual in situ testing of piping and components at the Indian Point 1 Nuclear facility after the plant was closed. The results are published in EPRI Report Number 8480, — Seismic Piping Test and Analysis, 1980.

Q5. Do you agree that Entergy's "confirmatory" CUF_{en} analysis of the feedwater nozzle fully incorporates thermal fatigue history for the feedwater nozzles?

A5. No. The NRC questioned the Applicant's "simplified analysis" with respect to the Feedwater nozzle as part of Request for Additional Information (RAI) dated October 9, 2007, during NRC LR Audit. The Staff was unsatisfied with the responses by Entergy, dated October 19, 2007 and November 14, 2007. During a meeting with Staff on January 8, 2008, the Applicant committed to performing refined analysis on the Feedwater nozzle including the use of actual operational thermal fatigue histories, as opposed to derived histories from the GE Specification. Incorporation of operational histories of the Feedwater nozzle was made a formal commitment in BVY 08-008, dated February 5, 2008.

An operational event that results in an unanalyzed thermal transient to the reactor vessel is relevant and cannot simply be set aside as licensees did for some period of time. The event at Vermont Yankee (VY) was no exception. The causal relationship between the event as found in historical records and the consequences in terms of thermal shock is key. During the early years of plant start-up and operation there where many unplanned forced shutdowns. I found 42 for VY. Not exactly a silky smooth running reactor. Three were downright dangerous.

GE and the Licensee did not fully predict all of the events in their shutdown estimates. Hence, those that were outliers needed detailed analysis. During the mid-1980s and into the 1990s this fact came to light starting with NUREG 0599 and others. Operational events led to the need for careful and refined transient analysis. The simplified method was shown to be overly dependent on skillful and experienced engineering. New methods removed the uncertainties and doubts of accuracy in CUF and

CUF_{en}. Not just cycle counting but examination of derivative temperature changes forced on the reactor vessel, the associated safe end, and on, of course, the feedwater nozzle as well. I know, because I was required immediately to notify the Technical Support Center (the emergency response area assembling management to provide technical support) for just such an event occurred on December 26th, 1986, at 6am, which brought down another plant for many months, placing the plant under its emergency plan. There was a concern that the plant would never operate again.

Based upon my examination of Vermont Yankee's historical records and my own experience of the challenge of maintaining nuclear plant operational history beginning with plant start-up, it appears to me that major thermal transients have likely <u>not</u> been incorporated into the operational history, as referenced in the SER. This deficiency is particularly significant where the reactor vessel has experienced an unplanned and unanalyzed transient that was outside the engineered design basis. Occurrence of these events throughout the industry was not as uncommon as one might presume.

Assessment of transient impact to specific component life is required following such an event to reestablish fidelity with the plant's design basis and is accompanied by additional fatigue analysis. The outcome of the engineering analysis holds one of three possibilities: (1) severe damage has occurred to the nozzle or vessel (less likely), (2) no additional fatigue usage outside the GE Specifications has occurred (also not likely), or (3) some additional usage outside the GE Specifications has occurred and therefore the component life is shortened (likely). Assessment and incorporation of the assessment of these impacts into plant operating records is essential to providing a basis for effective aging management programs.

An example of an historical Vermont Yankee event with the potential to impact the useful life of a number of systems, structures, and components occurred on December 1, 1972. On that date, the reactor automatically scrammed when an internal fault on a startup transformer resulted in a loss of offsite power. The emergency diesel generators automatically started and connected to their electrical buses. The high pressure coolant injection (HPCI) system got an automatic start signal on high drywell pressure, but failed to start. The operators manually started HPCI. Three relief valves opened when reactor pressure increased to 1,130 pounds per square inch gauge. A fourth relief valve should have opened, but failed to do so. One of the three relief valves that opened chattered on its seat about 100 psig below its set point. The transient was significant as reflected by the fact that odds of a core melt from this single event were 1.4E-3. See, Exhibit UW-24. More significant to the issue of fully recovering the record of all transients and accurately incorporating them in assessing remaining fatigue life is the assessment of wear, damage, and stress on each relevant component during each significant transient event.

There are other examples of transients that appear to have not been incorporated as input in the refined fatigue analysis. During the period from 1973 through 1977, Vermont Yankee experienced 42 unplanned forced shutdowns. This is a significant number, and expended much of the fatigue life of the reactor vessel and feedwater nozzle. See Exhibit UW-25.

Of these 42 forced shutdowns, in 1976 Vermont Yankee experienced 10 unplanned reactor scrams. Exhibit UW-24. One of these, on July 6, 1976, occurred during surveillance testing when the air operator plunger on a relief valve did not move when air was applied. Two of the other three relief valves failed. The failures were traced to air operator diaphragms damaged during excessive heating. The damage was attributed to improper insulation in the proximity of the diaphragms and an extended operating cycle. Core melt frequency for this event was an astoundingly high number 6.25 E-2. Exhibit UW-24. Again, the event stressed a number of systems and impacted the fatigue life of numerous components.

I made a comparison of the Engineering Design Input document, EN-DC-141, Rev. 3 provided to NRC by Entergy, to available records contained in the following documents and as compared to the responses provided to Dr. Chang's questions contained in Exhibit UW-26, "NRC Audit 10/09/07, with responses provided 10/18/07."

It appears that, in Entergy's calculation of 60-year CUFs in its CUFen reanalyses, operational histories were not properly or accurately compiled and that instead of documented transients, *estimated* thermal transient histories were used to predict the number of Reactor Thermal Cycles for 60 years. Purported added conservatisms remain unqualified and unjustified. The estimates of thermal transients are provided on Attachment 1, Page 1 of 6, EN-DC-141, Rev. 3. See Exhibit UW-27 "Design Input Record, Environmental Fatigue Analysis for Vermont Yankee Nuclear Power Station."

Q6. Why is this of concern in assessing the validity of Entergy's CUFen reanalysis?

A6. Refined fatigue analysis fidelity largely turns on correct design inputs. The simplified Green's Function method challenged by Staff on January 8, 2008 and in other records, was essentially about uncertainty in assumptions and estimates. My observation is that this particular design input is an ungrounded estimate, an *assumption,* and not an actual historical number; any conclusion stemming from it, therefore, cannot be relied on without corroboration. Clearly, to proceed with estimates based on a flawed record of all transient events is not appropriate. The rationale provided for not using actual transient operational cycles as found in Exhibit UW-26 at sequential page no. 8 (Bates number - NEC069994), is not valid in the event of a thermal transient event that was outside the original design basis. Entergy, has not shown that those events were incorporated.

Second, the estimated transient history – *assumption* – may or may not be conservative. As noted above, the plant experienced certain transients during its operational life from initial plant start up and testing, commercial operation, then uprate to 120% power beginning in 2004. Actual excursions, in particular those that appear to be outside the GE design specifications, should have been accounted for in the refined analysis. From the analysis provided, at least in the first example, they were not.

Third, considering Extended Power Uprate contributing factors such as increased flow, component modification, increased vibration, and increased core heat and neutron flux, the transients experienced by the plant beginning with power escalation to 120% should be given more weight in forecasting thermal transient cycles. There is no credible basis provided in the Applicant's analysis that justifies thermal cycle projections to 60 years.

In summary, by using estimated histories as opposed to actual history, specific transients that shorten the component fatigue life appear not to be acknowledged or included in the Applicants fatigue analysis, making the results including CUF_{en} unsubstantiated.

II. <u>NEC's Contention 4: Flow Accelerated Corrosion Plan</u>

Q7. Have you reviewed the initial statements of position, direct testimony and exhibits concerning NEC's Contention 4 filed by Entergy and the NRC Staff?

A7. Yes. I have reviewed Entergy's Initial Statement of Position on New England Coalition Contentions (May 13, 2008), and the Joint Declaration of James C. Fitzpatrick and Dr. Jeffrey Horowitz on NEC Contention 4 – Flow Accelerated Corrosion (May 12, 2008) and exhibits thereto. I have also reviewed the NRC Staff Initial Statement of Position on NEC Contentions 4, and the Affidavit of Kaihwa R. Hsu and Jonathan G. Rowley Concerning NEC Contention 4 (Flow-Accelerated Corrosion) (May 13, 2008), and exhibits thereto.

Q8. Entergy contends that you have no experience or expertise relevant to the testimony you have provided concerning NEC's Contention 4. How do you respond?

A8. I have extensive experience in development of engineering programs including controls for design change processes, configuration management programs and comprehensive initiatives in affecting operating nuclear power stations. These processes typically involve complex multifunction and multi-organization challenges. These programs are often mandated under federal regulations, or committed programs for a licensee to re-establish fidelity with its current design basis and license conditions. I have substantial experience in, for example, implementation and validation of NUREG 0737, "Clarification of TMI Action Plan Requirements," and was a principal manager in the successful restoration of Indian Point 3 from the NRC's Watch list, as well as Millstone Units 2 and 3. For the Tennessee Valley Authority, specifically the completion of the Watts Bar Nuclear Plant, I developed a program entitled "Program to Assure Completion and Quality." For Georgia Power's Plant Hatch, I developed and implemented a

Configuration Management Program, led in-house Safety System Functional Inspections, and an Electrical Distribution Function Inspection so as to prevent Plant Hatch from going on the NRC's watch list. For Northeast Utilities, I developed a multiple department and multi-function program to reestablish the fidelity of the design basis and licensing basis, including identifying, dispositioning and either eliminating or implementing over 30,000 regulatory commitments. My leadership in establishing and implementing these programs – successful initiatives – was well-received by the Licensee and well-received by the regulator. By their transparency to the community, they were generally accepted as improvements by the Licensee in protecting the health and safety of the public and minimizing risk to public assets.

As a seasoned engineer, manager, and problem solver, my expertise and track record demonstrate successfully implemented solutions to complex organizational, technical, or regulatory challenges in nuclear plant operations.

Applying my expertise in Engineering Design Control Programs, I note that Entergy's proposed Flow Accelerated Corrosion management program is based on use of a predictive modeling tool derived from an empirically based program with heavy reliance on engineering judgment, coupled with experience, oversight, and effective monitoring of FAC-related wear to certain vulnerable plant systems. My expertise in program management focuses on correct and effective implementation of the program and finding a record that is auditable, defendable against program requirements and transparent. To quote the NRC Staff's position regarding flow accelerated corrosion, "Corrosion is not an exact science. Due to epistemic and aleatory uncertainty, absolute wear rates cannot be determined…." NRC Staff Initial Statement of Position at 20. ~~Thus the burden in~~

constructing and maintaining an effective FAC program must ~~emphasize~~ reliance on engineering judgment, ~~coupled with~~ experience, oversight, and effective monitoring of FAC-related wear.

While I do not purport to be intimately familiar with the empirically based CHECWORKS algorithm, I can attest to sufficient expertise in evaluating the fidelity of a comprehensive FAC program. I believe that the parties and witnesses are not in dispute that an effective flow accelerated program is highly dependent on sound engineering judgment and precise implementation, including the program goal of effective management of the predictive results, so as to preclude wall thinning beyond acceptance criteria during the license renewal period.

A. Summary Rebuttal

Q9. Do you believe that Entergy's Flow Accelerated Corrosion Management Program as implemented to date will be adequate for purposes of aging management during the period of extended operation, as Entergy and the NRC Staff assert in their initial statements of position and direct testimony?

A9. No. Entergy asserts on page 34, 35, and 37 of their Intial Statement of Position to New England Coalition Contentions, that their intention to credit the existing program as demonstrated to be adequate with no changes planned. Staff underwrites this assertion as well on page 20 of the NRC Staff's Initial Statement of Position on New England Coalition Contentions. I do not agree the program as implemented to date is adequate.

NEC raised significant concerns regarding the Flow-Accelerated Corrosion Program and asserted that the application for License Renewal submitted by Entergy for Vermont Yankee does not include an adequate plan to monitor and manage aging of plant equipment due to flow-accelerated corrosion during extended plant operation. The responses provided in summary disposition as well as Entergy's Reply and Staff's Reply do not address NEC's concerns and in fact raise troubling new concerns beyond simply the sufficiency of the Vermont Yankee flow-accelerated corrosion program as presently credited for license renewal.

The Applicant's response summarized during motion for summary disposition is that it's *present* FAC program is consistent with industry guidance including EPRI NSAC 202L R.3 and that the use of the CHECWORKS model is a central element in the FAC program implementation. The Applicant stated that it is relying on its current program for FAC management for the license renewal period, and "furthermore, the FAC program that will be implemented by Entergy is the *same program* being carried out today… [and] will meet all regulatory guidance." See Entergy Reply at 34.

Entergy represents that it will rely on its current FAC management program for purposes of FAC management during the license renewal period, that no changes to this program are planned, and that this program complies with EPRI guidelines. *See,* Entergy's Initial Statement of Position on New England Coalition Contentions at 34 ("The current FAC program, which will be used during the license renewal period, meets industry *practice as reflected in NSAC-202L…").* My review provided in pre-filed testimony shows that Entergy's current program is not in compliance with EPRI guidelines.

Q10. Entergy asserts on page 34 of its Initial Statement of Position that "the program has been reviewed, audited, and inspected with only minor, mostly

administrative issues identified," and discounts its own Quality Assurance audit, which declared the program "unsatisfactory." How do you respond?

A10. I believe that these statements indicate that Entergy may have ignored or misconstrued the fundamental requirements of 10CFR Part 50, Appendix B, "Quality Assurance Requirements for Nuclear Power Plants." It appears that federal requirements for Quality Assurance (QA) are being set aside. Quality Assurance Division Audit No. QA-8-2004-VY-1 declared the Flow Accelerated Program "unsatisfactory," submitted two Condition Reports, and found five findings and seven areas of improvement. *See,* Exhibit NEC-UW_09 at 2. Yet Entergy's Initial Statement of Position interprets the 38-page document as containing "only minor, mostly administrative issue[s]." Entergy Initial Statement of Position at 34.

Furthermore, the Entergy asserts this single analytical tool for predicting unacceptable wall thinning should, as policy, be set aside as it was for four components, See Exhibit NEC-UW_20 at 5 of 14. Thus the Entergy provides a second indicator where the Licensee obliquely waived Appendix B requirements for Quality Assurance. See Entergy Statement of Initial Position at 48.

That again is misapplication of the requirements of Appendix B, which is particular to the Flow Accelerated Program, where the Applicant's only defense to its failure to prepare condition reports associated with unacceptable wall thinning, a prediction derived from its own analysis, is somehow that this component shown not to be meeting quality standards is deemed acceptable "as is" until the next outage. Therefore, there are two indications of a troubling and clearly deep-seated failure to properly implement the requirements of a compliant Quality Assurance Program. Appendix B to

10 CFR Part 50 requires among other things, Section III, "Design Control; and Section XVI, "Corrective Action" The latter section of the rule includes the following:

> Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to the appropriate levels of management.

Quality Assurance requirements are not a *practice* that may or may not be voluntarily implemented by the Licensee, but are in fact are <u>regulatory</u> requirements promulgated under federal rules. The Applicant incorrectly asserts that a failure theoretically predicted by the CHECWORKS model is somehow treated differently than a failure predicted by actual inspection data. The Applicant is incorrect in assuming that a failure predicted by CHECWORKS does not meet the threshold for a condition report, with timely follow-up or corrective action, as fundamentally required under Appendix B. The Licensee has no regulatory grounds to escape a determination of potential failure by reason of its assertion that "if a planning tool such as CHECWORKS .....determines a *theoretical* conclusion... as such no condition reports are required." See Entergy Statement of Initial position at 48. This improper rationale is essentially analogous to a Licensee *ignoring* a Technical Specification requirement calling for declaration of a component or system to be classified as inoperable and a Limiting Condition of Operation started if a surveillance is missed. In the analogous situation, a component is administratively (theoretically) declared inoperable, although its actual functionality is unknown.

The consequences of the Licensee's apparent policy regarding Appendix B requirements, for Vermont Yankee's Flow Accelerated Corrosion Program are significant and have broad implications to multiple programs relied upon for renewal. Essentially, following the Licensee's logic every program can be viewed as theoretical when it is intended to be a predictive tool. The implications of Entergy's statements are profound and raise questions regarding credibility of all the Aging Related Management Programs proposed and Entergy's actual intentions for monitoring, and maintaining the plant if the license is extended.

Q11. Has applicant provided in its response any reasonable assurance that pipe thinning beyond code limits will not occur in the period between outages?

A11. No. Quite to the contrary, the applicant has stated at page 48 of its Initial Statement of Position, in reference to page 5 of 14 of PP7028 Piping Inspection Program, Exhibit NEC-UW_20, that wear rates predicted to exceed code limits will not be acted upon until the next outage. Based on statements made by the Applicant regarding pipe thinning predictions including negative time to inspect (described as negative T_{min} in the document) and predictions of unacceptable wear rates leading to thinning beyond code limits prior to the next outage, coupled with the decision to not prepare condition reports (or an analogous report consistent with requirements of a corrective action program as part of Appendix B), it is my opinion that reasonable assurance is not provided, and that the NRC Staff erroneously concluded that the program is complete, correct and adequate.

Therefore, my opinion is that the staff erroneously concluded that the program is complete, correct and adequate.

Q. 12 Does Entergy's Initial Statement of Position resolve the programmatic weaknesses you identified in your direct testimony, including open corrective actions, stale open action items from condition reports, and the negative assessment of the program stated in the 2006 cornerstone roll up report?

A12. No. Entergy characterizes the issues I have identified as shortcomings in the documentation paperwork with no substantive implications. I disagree. Any one of the Quality Assurance findings are significant. For example, a classic indictor of a problematic program is age of open corrective actions. A second indicator is number of Condition Reports, and number of extensions planned and then postponed to implement necessary actions to maintain the program current. Data drawn was sometimes more than fifteen years old.

Entergy expends much discussion, largely on a generic basis, on what ought to constitute a good FAC program. Entergy Statement of Initial Position at 36. However, Entergy does not respond to or take into consideration the VY's actual repeated historical failures to implement the FAC program from 1999 to the present day, which I have identified in my report, filed in this proceeding as Exhibit NEC-UW-03. With few exceptions, these numerous programmatic failures go unchallenged by Entergy.

Most significantly, successive implementation of CHECWORKS to current plant design inputs is undisputed as a mandatory element of the program, as required under NSAC 202L rev. 2 and rev. 3. Entergy makes no claim that this was consistently done.

Successive data passes at appropriate intervals, with ~~scope selection,~~ current operating conditions etc, ~~taken~~ into consideration are a fundamental element to identifying appropriate grid selection points, and trending ~~of wear~~ items. However, this obligation was consistently ignored for many years and at best done in fragments for many outages. See Exhibit NEC-UW_03, "Evaluation of Vermont Yankee Nuclear Power Station License Extension." This approach places the reviewer in the untenable position of having to look a look at wear data for trends with only very limited data points and then speculate as to whether the data set is sufficient. ~~This approach is invalid.~~

Detailed Review of Entergy and Staff Reply

Q13. Do you take issue with the general merits of the approach to FAC management recommended in NSAC 202L?

A13. No. My focus is strictly on the adequacy of the implementation of NSAC 202L at VY.

Q14. On Page 38 of its Initial Statement of Position, Entergy makes the following assertion regarding FAC Susceptibility review: "the only CHECWORKS inputs affecting FAC wear rate that need to be changed to model uprate conditions were the flow rate and the temperature. These were updated at VY upon implementation of the EPU." Do you agree that flow rate and temperature are the only inputs that were necessary to incorporate into the model?

~~A14. No. I disagree. Identification~~ of the added inputs should be ~~made, incorporating~~ the results ~~of all~~ pertinent susceptibility analyses. Apparently, this ~~has not~~ been done. First, Exhibit E4-32 is a copy of a susceptibility analysis performed by Entergy in 2005. This analysis was performed fully five years after the previous analysis was completed in 2000. This five year gap is found by examining the dates associated with the 2005 Susceptibility analysis. Numerous changes to the plant occurred between 2000 and 2005. For example, in 2003, the reactor recirculation and residual heat removal piping was replaced. See, Exhibit NEC-UW_27 at 6, Attachment 1. Second, ~~operational factors (such as TECH~~

SPEC changes, configuration changes, and material changes) should have triggered a new susceptibility analysis well before the analysis performed in 2005.

In brief, beginning in 2004, substantial plant modifications were performed, including system modifications etc, yet a current Susceptibility Analysis was not performed until 2005. The premise that only flow rate and temperature input changes were needed is not properly supported and incorrect.

It is apparent that Vermont Yankee's FAC program management was broken from February 28, 2000 through October 25, 2005 based upon lack of Susceptibility Analysis alone. A comparison of program scope for piping inclusion, exclusion, small bore, large bore, fluid type etc, should have been incorporated into the FAC Program under the station Engineering Design Controls program on an ongoing basis—essentially any time a plant modification, system function change, or operational change was contemplated. Based upon the Applicant's information provided on page 38 of Entergy's Statement of Initial Position, as well as the Table 2 of Exhibit E4-32, the susceptibility analysis was set aside for more than five years, losing both continuity and assurance that all modifications have been evaluated and taken into consideration.

Proper grid point selection, proper sampling, proper frequency and the consistent integration of new data all serve to remove speculation and uncertainty in the accuracy of CHECWORKS. This fact by itself provides the impetus for a "new baseline," especially in light of the fact that a current baseline is, for all practical purposes, lacking. In conjunction with the relative uniqueness of the CPPU power uprate—chemistry changes, geometry changes, and of course velocity changes, the need for a "new baseline" is compelling. The strength of the CHECWORKS and the NSAC 202L methodology

~~endorsed in the GALL Report~~, is in its successive passes with ~~tight control of changes in requisite input variables. These core elements have yet to be implemented.~~

In 2005, Entergy relied on ancient susceptibility data for component selection points, such as small bore piping from data circa 1993. *See* Exhibit NEC-UW_20 at page 12 of 14. Five small bore points were selected that had never been inspected previously, indicating loss of control of the program. ~~Entergy's defense of this methodology raises significant doubt as to the efficacy of the current program, and therefore the FAC program for the license renewal period.~~

~~A lack of a timely susceptible review can only serve to skew the results appropriate selection of specific wear points. An updated and inclusive Susceptibility Review should definitely have been required by NRC Staff in their review. It apparently was not.~~

~~The Susceptibility review did not appear to address wear points associated with plant modifications, and based upon the descoping of the inspection, even after recommending by engineering judgment, to include certain points they were not. *See* Exhibit E4-38 referenced in Entergy's Statement of Initial Position at page 39.~~

~~**Q15. On page 39 of its Initial Statement of Position, Entergy states that in 2007, RFO 26, the first outage since the EPU, the inspection scope was a total of 63 inspections performed, including 49 large bore inspections. Do you believe that Entergy met its commitment to increase the scope of inspection by 50%?**~~

~~**A15.** No. It is apparent on reviewing the record that Entergy first reduced the effective inspection scope and then enlarged it, in the process offsetting any "increase." A mirror~~

analogy would be the retail store that raises its prices on certain goods, prior to offering them at a sale discount.

Entergy's commitment to increase the number of inspection points by 50% was made in response to an RAI, acknowledged in Entergy's Statement of Initial Position at 39, but this commitment was tacitly fulfilled by increasing the number of inspection points for RFO 26 only after decreasing the number of inspection points (by descoping) for RFO 25. The Scoping document for RFO 25 contained significantly more inspection points. See, Exhibit NEC-UW_20, "PP7028 Piping FAC Inspection Program FAC INSPECTION PROGRAM RECORDS FOR 2005 REFUELING OUTAGE." On page 20, it states "The planned 2005 RFO inspection scope consists of 0137 large bore components at 16 locations…[a]lso, any industry or plant events that occur in the interim may necessitate an increase in the planned scope." In addition, criteria for inspection of components outside of CHECWORKS grid selection is articulated to include points simply because of the lengthy intervals since previous inspections. These include Feedwater piping, and Mainsteam piping. Id. at 3.

However, the number called for in the above scoping document is considerably more than the actual number of large bore components reported to be inspected during RFO 25, as in Exhibit E4-38, where the Applicant notes that it limited its inspection to 27 large bore points. The actual inspection of 63 large bore points for RFO 26 is about ½ of the number of planned inspection points for RF0 25, not 50% more.

Q16. Entergy disagrees with your statement in direct testimony that "trending to the high end of the range [for bench marking] is appropriate where variables

affecting wear rate, such as flow velocity, have significantly changed, as at VYNPS following the 120% power up-rate…". How do you respond?

A16. Entergy questions the relevance of the report brought forward in my direct testimony in support of this statement. The report in question is "Aging Management and Life Extension in the U.S. Nuclear Power Industry," Exhibit NEC-UW_13, or the "Chockie Report." Entergy asserts that this report does not support trending to the high end of the range where variables such as flow velocity etc have significantly changed, because it is not industry guidance, but a report produced at the behest of the Petroleum Safety Authority of Norway regarding aging management and life extension in the U.S. nuclear power industry.

The Chockie Report most certainly assimilates industry guidance, including regulatory rules and implementation of those rules, and compiles aging programs strictly with respect to the United States domestic nuclear power plants. On page 38, it answers exactly what is required if there is no pre-existing baseline, as is the case for Vermont Yankee. The use of the report by the Norway Petroleum Safety Authority has no bearing on its content. The report is on point to Contention 4.

The Chockie Report is applicable to the question of what constitutes an adequate baseline. Entergy assumes that its present baseline is adequate. ~~I believe after examination of the failure to adequately implement the program, that VY does not have an adequate baseline. The Chockie Report is a concise primer on the effective implementation of NSAC 202L, including CHECWORKS, and by inference impeaches Entergy's Application as well as the adequacy of NRC Staff Review.~~

Q17 Do you agree with Entergy's statement contained in a single paragraph on page 45 of Entergy's Initial Statement of Position that the following eight claims you made in your direct testimony have no merit?

a. **"that data from previous FAC inspections (prior to the EPU) were not entered into the CHECWORKS database (NEC-UW_03 at 2, 3, 6, 7-8, 15, 16, 17);"**

b. **"that CHECWORKS was not updated with the uprate parameters (id. at 5, 23);**

c. **that, for the period 2000-2006, VY failed to use a current version of CHECWORKS (id. at 6, 17);"**

d. **"that four components were predicted in 2004 to have wall thinning beyond operability limits (id. at 17-18, 22);"**

e. **"that open corrective actions identified in condition reports may not have been completed (id. at 3-4, 18-19);"**

f. **"that ranking of small bore piping was not done (id. at 8, 20);"**

g. ~~**"that the number of inspection points were reduced after the 2005 outage (id. at 7, 8, 20); and"**~~

h. **"that the 2006[1] refueling outage inspection "scope, planning, documentation, and procedural analysis appear to have been performed under a superseded program document" (id. at 5, 7, 20-21)."**

A17. No. I disagree. Entergy states that these claims have no merit but does not actually refute them, or specifically address the majority of the documents I cite in support of my direct testimony. Entergy's reply to my direct testimony consists primarily of conclusory denials.

Q18. Does this conclude your rebuttal testimony?

A18. Yes

I declare under penalty of perjury that the foregoing is true and correct.

U Witte

Ulrich Witte

At Westville, Connecticut, this 6th day of June, 2008 personally appeared Ulrich Witte, and having subscribed his name acknowledges his signature to be his free act and deed.

Before me:

____

Notary Public

My Commission Expires ____________________

MS. TYLER: I also move to admit the exhibits referenced in Mr. Witte's testimony which are Exhibits NEC W02-NEC W22.

(Whereupon, the documents referred to were marked as NEC Exhibit W02-W22 for identification.)

JUDGE KARLIN: Any objections?

(No verbal response.)

Hearing none, they so be admitted.

(The documents referred to having been previously marked for identification as NEC Exhibit W02-W22, were received in evidence.)

Anything else, Ms. Tyler?

MS. TYLER: No.

JUDGE KARLIN: All right. Thank you.

I think that's helpful to get the witnesses sworn in and their exhibits brought in to the evidentiary record this afternoon. Normally, at this point, we would begin questioning the witnesses. But we did have the request prior to the beginning of the evidentiary hearing in a written notice that Dr. Horowitz and I apologize, Dr. Horowitz, that your name tag says "Mr. Horowitz." We know it's Dr. Horowitz. We asked him to put together a brief presentation on CHECWORKS.

I would like to call upon you to give us that presentation at this point, sir, and you may go over to the podium if you find that helpful.

(Off the record comment.)

JUDGE KARLIN: All right. Let's take a pause.

(Pause.)

JUDGE WARDWELL: We requested a presentation that would be kind of a nuts and bolts discussion of how CHECWORKS works. I reviewed the slides and I think all the slides do achieve that goal with the exception of Slide 12. I think we will get to some of the things you want to talk about in Slide 12, but I'd rather do it as part of questioning rather than have you present it because I want it to be strictly as best we can an impractical presentation of what CHECWORKS is about.

So I would ask you to stop at Slide 11. Slide 13 is merely questions and we will have plenty of questions for you tomorrow on this which will cover what you said in Slide 12 also.

At this time, I would like to ask NEC's

witnesses if they've had a chance to review these overhead slides. Have you received these overhead slides before today?

(Off the record comment.)

With the exception of Slide 12, is there anything there that you feel is editorialized in regards to Dr. Horowitz's presentation of just the mechanics of how CHECWORKS works? Do you see any professional opinions on how effective it is or what it does, how it achieves it in a relative fashion of effectiveness or that type of thing? Do you have any objections to what he's saying?

MR. WITTE: Your Honor, for the record, I have not had a chance to review this.

JUDGE WARDWELL: You did receive it before though.

MR. WITTE: Yes, sir.

JUDGE WARDWELL: Thank you.

Dr. Hausler. Thank you, Dr. Hopenfeld.

DR. HAUSLER: (Off microphone) Your Honor, the slides are really in the sense of radiation what Dr. Horowitz is going to explain to us. In that sense, they really are -- objection or opinion of --

JUDGE WARDWELL: Fine, we will wait until later then.

Dr. Horowitz, proceed and if I do stop you, it is because I have the feeling that it's more editorialized also and I'll ask you to move on. But other than that, proceed until either --

DR. HOROWITZ: First of all, good afternoon. I appreciate the opportunity to speak about CHECWORKS before you this afternoon.

(Inaudible.)

Should I announce that?

JUDGE WARDWELL: Yes, that would be fine.

DR. HOROWITZ: So background, the story I'm about to tell really begins with the Surry accident of Unit 2 in December 1986. Surry is a two-unit PWR station located in Virginia. As a result of that accident, four men were killed. There was plant damage. There was also injuries to other workers and that prompted an investigation by all sorts of parties and, as a result of the investigation, it was determined that the cause of the rupture was flow accelerated corrosion as we now call erosion corrosion mechanism. This mechanism is a dissolution of the iron oxide coating from steel surface and if it continues on unabated it will eventually result in rupture.

The fact is that there were large portions of the elbow in question eroded away. It corroded away. In fact, about half of the material, more than half of the material, of the elbow was gone.

So, as a result of this accident, there was a need for U.S. nuclear units to inspect single phase piping. By single phase, I mean water only and water only as opposed to two phase which contain water and steam. At the time of the accident back in '86, there were only very limited programs in the U.S. to inspect single phase piping.

Because of the situation, both EPRI and NUMARC, an industry organization, committed to develop a computer program to assist utilities in selecting inspection locations to look for flow accelerated corrosion damage.

At the same time, back in the spring of '97, NUMARC issued programmatic guidance which is in effect the father of NSAC-202L.

JUDGE KARLIN: What does NUMARC stand for please?

DR. HOROWITZ: Nuclear Utility Management and Resources Council.

JUDGE KARLIN: All right. Thank you.

DR. HOROWITZ: Over the past 20 something years, CHEC has evolved in the CHECWORKS and I'll talk about the evolution a little bit.

Okay. Next slide, Slide 3, in view of the current constraint, the U.S. utilities were planning for outages and had to have selection inspection locations selected. So we were under a great deal of pressure to develop this tool to help them to select inspection locations and, in fact, the program was released within seven months of the Surry accident. It was released from a little over three months since NUMARC made the decision to go ahead with the program.

So what we did is we gathered laboratory data from England from Central Electricity Generating Board and from France from the Electricity of France, the national utility, and we also gathered plant and laboratory data from Siemens in Germany. In fact, at the time, we obtained all known laboratory data on the subject and we were in a unique position because nobody had ever looked at all that data together.

JUDGE KARLIN: May I ask? When you say "we," who is "we"?

DR. HOROWITZ: We at the time of starting the CHECS was the EPRI program manager and myself.

JUDGE KARLIN: Okay.

DR. HOROWITZ: So what we did and essentially the two of us and later in the game we had help from a programmer used the scientific knowledge available at EPRI of corrosion experts and the laboratory data and they are mostly from Europe and we designed a new correlation to relate the plant conditions with rates of corrosion. Now Slide 4 please.

So we were not the first to do this. There was previous work, again, mostly in Europe and, in fact, gentlemen named Keller and Kastner, both from Germany and both work for Siemens, had during the past roughly 15 years developed their own models for predicting rates of flow accelerated corrosion. We also had the benefit of some scientific work done with Phillipe Berge who has since retired from EIF who did a great deal of background work in this area and we came up with a simple looking model.

I say simple looking because it's a product of seven factors. Now naturally the factors themselves are not simple numbers. They're complicated functions in general. And you can see these six factors, the first six factors, we used in CHEC and when we extended the program to two phase, we added factor seven for void fraction.

Just very, very briefly, the factors we considered are temperature of the fluid, the mass transfer factor which is related to the mass transfer that a straight pipe would experience, a geometry factor which relates the straight pipe mass transfer to that in the fixings such as an elbow, the pH factor and oxygen factor that accounts for water chemistry and the alloy factor to account for the composition of the material. Next Slide No. 5.

So coming along was basically the last of the first generation programs. We had the advantage over previous workers and we knew what they did. But, more importantly, we had the largest database of experimental and eventually plant conditions.

We also took the more sophisticated approach particularly when we went to CHECMATE two years later of incorporating local conditions of water chemistry and the flow and we did that by having separate features to form detailed calculation of the plant chemistry and also a flow as desired by the analysts.

We also used geometry factors based on plant data. In the past, geometry factors were a concept developed by Keller in the early '70s and Keller was working steam turbine. So he developed a large number of geometry factors. From what we can tell and a lot of this knowledge has been lost, what he used is he used comparisons between overall pressure drop and the rate of flow accelerated corrosion. We, on the other hand, use plant data from actual plants compared to straight pipes and we also had insight from copper modeling tests which is explained in one of my exhibits how exactly that's works.

What we've done over the years, this was 1987, in the 21 years or so is we have continually looked at the data as it becomes available. Laboratory data has becomes available, limited now to France, particularly in the 1990s and periodically we'll go back and we'll look at all available plant data and go back and examine how well the correlation performs. When a new issue occurs or we get reports from users that something is not working as well as we'd like it we will do a separate study and look at that individual parameter.

Slide 6, Input Parameters. When we designed the program, one of our foremost goals was to have a program that utility engineers could use. So therefore the inputs to the program had to be readily available to utility engineers. The way it's structured currently in CHECWORKS is we have five classes of input data just to divide this out for some

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The first is a heat balance diagram and the heat balance diagram is a logical representation of how the major components in the power are connected, having feedwater heaters and injection lines, whether it's a reheat or not, and we have kind of a computerized tinker toy to allow the user to connect them up together. But this is done once when the model is put together.

To make the program work, you also have to include global conditions, in other words, things that affect everything in the plant such as operating hours, power level, water chemistry parameters and operating time. This is done for each operating period. So this is a relatively small job to complete for the plant.

By far, the most information that's put in is at the component level and I've listed some of the things here. So, for each component you're analyzing, you have to define the geometry and material, the flow rate, the thermal dynamic conditions, parameters like this. If it's a valve, some other information. If it's an elbow, some other information. But that's pretty low level.

You also can input the component

replacement information. The component is operated for awhile. It needs to be replaced. You could put that in the program to find the new component, to find whether it was replaced and this becomes very important because the way the program works is it does a step-wise integration of the wear and you have to know how old it is to do that properly.

And, lastly, inspection data. If available, you can input inspection data which is normally a thickness matrix at a given time. Okay. Slide 7 please.

Plant Modeling. So conceptually, we've put together a plant model. How do we use it? We have all the data in. What do we do next?

The analyst goes through and divides the plant into a number of lines. We call them analysis lines and the lines do not have to be physically attached, but they represent components which have the same water chemistry and generally the same temperature. What that means is there are components we expect to behave in the same way and depending on the complexity of the reactor itself and the amount of inspection data we have available here, there's typically between 20 and 50 of these lines, sometimes more. But that 20 to 50, 25 to 50 is a good rule of thumb.

Using all the information available to the program, now the analyst tells the program to calculate for a given analysis line. That program will for each operating point, excuse me, for operating period calculate the corrosion rate, multiply by the time and calculate the amount of incremental wear for that operating period. At the end of the process, the individual pieces will be summed up and the total predicted wear will be obtained.

Next slide is No. 8. So specifically we tried to design CHECWORKS to do is to handle changes of conditions and the reason it's true is if conditions aren't changing and I was in Japan last year and the Japanese reactors tend to run at consistent conditions, consistent chemistry, forever and that's the way to do things over there the tool is much less useful because the advantage of the tool, for example, in the early '90s pressurized water reactors were going through a large improvement of water chemistry. They changed the chemicals they used. They changed the pH. They changed the mix of chemicals used and having a tool like this you can evaluate in advance of making a change what the impacts would be. Changes of operating conditions and water chemistry and for each operating period in the program, the conditions are defined and the calculations are made.

In doing this design of the program, forecasting change is one of the main things we were concerned about and the second was in like all the components, both components with inspection data and without inspection data. It's important to keep in mind that CHECWORKS is a tool to help the engineer select inspection locations. CHECWORKS does not produce a list of inspection locations. It's not automatic. You need a human being between the program output and the inspection list generated. Slide 9.

That's overall how the program works. Now I'll get into a little more detail about how it's actually used. There are two modes of operation called Pass 1 and Pass 2 and Pass 1 does a prediction using the correlation without any consideration of inspection data and this just gives you a raw prediction. It's typically only used when a line has not been inspected. A line is not considered. And as I said, it's seldom used particularly in the CHECWORKS program.

Pass 2, on the other hand, at the opinion of the analyst considers inspection data and Pass 2 in the -- relates the predicted amount of wear and the amount of wear measured at that time. The next slide please.

So a user using the program after doing the Pass 2 analysis has the ability to look in graphical basis and also tabular basis how the predictions compare and this is an important part of the process and we strongly recommend that users consider spending time looking at the information and trying to understand what the information is telling the analyst. Note that the line correction factor is computed separately for each line analyzed and the user has the ability to, I mentioned that before, see the results. And keep in mind that the line correction factor is calculated by the program and is displayed to the user. Next slide which is the lat one, Slide 11.

So does the program give the user? The program in the various forms, tabular and graphical, gives information for each component to analyze and proves the predicted wearing on an average basis and for the last operating period, the predicted thickness and the predicted time for each user-defined critical thickness. And for Pass 2 analysis, the user also gets the line correction factor.

Thank you. Any questions?

JUDGE WARDWELL: Thank you, Dr. Horowitz. We'll have questions for you tomorrow on this. But we'll wait until then to start pulling that back out again and get into the middle of that.

JUDGE KARLIN: Thank you, Dr. Horowitz. Yes. I think with that we probably have hit a breaking point that would be good to break now and reconvene tomorrow morning at 8:30 a.m. crisply if we can. It may be a long day. We may go later than 5:00 p.m. tomorrow, as late as they will let us stay here and it takes. But I don't think we'll have to go late. We're just going to ask questions and see how far we get.

Right now, it's a little anticlimactic for all these excellent witnesses to be sworn in and not get a chance to speak. But we will ask the questions tomorrow rest assured. You'll get your chance. So we will stand adjourned for the day and reconvene tomorrow at 8:30 a.m. Thank you. Off the record.

(Whereupon, at 4:34 p.m., the above-entitled matter was concluded to reconvene at 8:30 a.m. the next day.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of: Entergy Nuclear Vermont Yankee, LLC & Entergy Nuclear Operations, Inc.

Name of Proceeding: Hearing

Docket Number: 50-271-LR, ASLBP No. 06-849-03-LR

Location: Newfane, Vermont

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.

Toby Walter
Official Reporter
Neal R. Gross & Co., Inc.