RAS M-77



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 | ) | Docket No. 50-271-LR |
| and Entergy Nuclear Operations, Inc. | ) | ASLBP No. 06-849-03-LR |
| | ) | |
| (Vermont Yankee Nuclear Power Station) | ) | |

**ENTERGY'S SUPPLEMENTAL STATEMENT OF POSITION ON NEW ENGLAND COALITION CONTENTIONS 2A/2B**

Pursuant to 10 C.F.R. § 2.1207(a)(2) and the Atomic Safety and Licensing Board's ("Board") Initial Scheduling Order dated November 17, 2006 ("Scheduling Order"), Applicants Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (collectively "Entergy") hereby submit their Supplemental Statement of Position ("Supplemental Statement") on New England Coalition Contentions 2A/2B. This Statement is supported by the "Joint Supplemental Declaration of James C. Fitzpatrick and Gary L. Stevens on NEC Contentions 2A and 2B – Environmentally Assisted Fatigue" ("Fitzpatrick – Stevens Supp. Dec."), Exhibit E2-38.

## I. APPLICABLE LEGAL STANDARDS

The legal standards that apply to this proceeding are described in Entergy's "Initial Statement of Position on New England Coalition Contentions" dated May 13, 2008 ("Initial Statement of Position") and need not be repeated here.

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## II. APPLICANTS' SUPPLEMENTAL STATEMENT OF POSITION ON FACTUAL ISSUES RELATING TO NEC CONTENTIONS 2A AND 2B

### A. Entergy's rebuttal witnesses

Entergy's rebuttal testimony on NEC Contentions 2A/2B is presented by the same two experts who submitted direct testimony in support of Entergy's Initial Statement of Position on these contentions: Messrs. James C. Fitzpatrick and Gary L. Stevens. As demonstrated in their direct testimony, Messrs. Fitzpatrick and Stevens have ample qualifications and experience in the analysis of environmentally-assisted fatigue in key reactor components of boiling water reactors, and are well qualified to offer testimony on these contentions based on both their technical expertise and their first hand knowledge of the issues raised in NEC Contentions 2A and 2B as they apply to VY.

### B. Entergy's Refined Analysis Methodology

40.A[1] The finite element models used for all of the VY refined analyses and the confirmatory analysis are axisymmetric and provide detailed, three-dimensional stress results. The "1-D" designation in the "Affidavit of Kenneth C. Chang Concerning NEC Contentions 2A & 2B (Metal Fatigue)" dated May 12, 2008, Staff Exhibit 2 ("Chang Affidavit") does not refer to the geometric modeling of the component, which is three-dimensional, but rather refers to an analytical simplification that was used to approximate all six stress components with a single stress term. Fitzpatrick – Stevens Supp. Dec. at A12.

40.B The Chang Affidavit at A16 agrees that the confirmatory analysis of the feedwater nozzle performed by Entergy at the NRC Staff's request (Exhibits E2-25 through E2-27) was conducted in accordance with the methodology set forth in ASME Code Subsection NB, Subarticle NB-3200, but implies that the refined analyses do not conform to the guidance in that section of the ASME Code. In reality, all of the refined analyses and the confirma-

[1] The factual statements herein are numbered to follow consecutively the factual statements in the Initial Statement of Position with respect to NEC Contentions 2A/2B, the last one of which was number 40.

tory analysis performed by Entergy were conducted in accordance with the methodology set forth in ASME Code Subsection NB, Subarticle NB-3200. Id. at A13.

40.C Analyses performed using the ASME Code methodology rely to a degree on the judgment of the analyst on items such as stress component simplification, transient definitions, heat transfer coefficients, material properties, and other input parameters to ensure that the analysis results are appropriate and bounding for the intended application. The single stress term simplification is appropriate and conservative and the use of such a simplification is consistent with the ASME Code Section III fatigue calculation methodology. Id.

40.D The refined analyses performed for the VY nozzle components use many of the same judgments that have been routinely applied in current licensing basis analyses historically performed throughout the industry for Class 1 components that have used ASME Code, Subsection NB, Subarticle NB-3200 methodology. Id.

40.E The environmentally adjusted cumulative usage factor ("$CUF_{en}$") at the feedwater nozzle corner was calculated to be 0.63 in the refined analysis. This value is higher than the $CUF_{en}$ value of 0.35 calculated at the feedwater nozzle corner in the confirmatory analysis. Whereas the cumulative usage factor ("CUF") value, prior to adjustment for environmental effects, was higher for the confirmatory analysis than for the refined analysis, the higher value of CUF in the confirmatory analysis was the result of the different implicit conservatisms incorporated in each analysis. That one conservative analysis is slightly higher than another does not render the first nonconservative (and indeed, it would be surprising if they were identical). Id. at A14.

40.F When the methodological differences between the refined and confirmatory analyses are all collectively considered in each evaluation performed, the refined analysis methodology used by Entergy remains conservative, as demonstrated by the final $CUF_{en}$ results. Id.

40.G The refined analyses for the feedwater, recirculation outlet and core spray nozzles were performed using consistent methodologies and conservative analytical judgments. Therefore, if all of the same methodologies and analytical judgments are applied to the recirculation outlet and core spray nozzles as were applied to the feedwater nozzle, similar trends in $CUF_{en}$ values will result. Based on the results obtained from the two analyses performed for the feedwater nozzle, the results of the refined analyses for the recirculation outlet and core spray nozzles are also conservative. Id. at A15.

40.H There is no doubt that the locations chosen for conducting the analyses of the feedwater, recirculation outlet and core spray nozzles were appropriate. For the safe end of each nozzle where thermal stresses are controlling, the evaluated location was selected as the location of maximum thermal stress for a bounding 500°F to 100°F temperature step transient at 100% flow conditions. For the corner of each nozzle where pressure stresses are controlling, the evaluated location was selected as the location of maximum stress due to internal pressure. These selections of controlling locations were used throughout all of the VY analyses, including the confirmatory analyses of the feedwater nozzle corner, and were identified as such in the analyses. Id. at A16.

**C. Transient Cycle Projections**

40.I The Chang Affidavit at A10 indicates that the Staff cannot determine the level of conservatism inherent in the estimated number of transients used in the EAF analysis. However, the number of transient cycles that are estimated to be experienced at VY as part of the EAF analysis is conservative. Id. at A17.

40.J To insure a realistic projection for the thermal transient cycles and events expected for 60 years of operation, the Thermal Cycle Diagrams from a later vintage BWR were used as a starting point. The VY Design Specification transients were mapped onto the BWR Transient Diagrams. Then, projections for 60 years were made based on the numbers for 40

years in the VY Design Specification, the numbers actually analyzed in the VY Design Stress Report, and the number of cycles experienced by VY in approximately 35 years of operation. For example, 200 Startup / Shutdown cycles were included in the original VY Design Specification. However, 300 Startup / Shutdown cycles were conservatively used in the EAF analyses for 60 years of operation. Id.

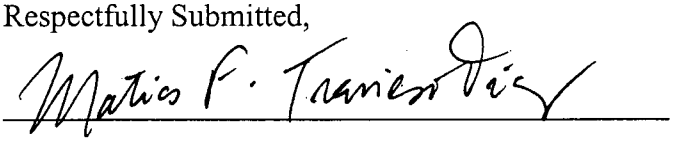
40.K The 60 year projections of operating events used in the VY EAF analyses are equal or greater in number to the numbers of cycles in the original VY Design Specification for 40 years. Actual plant cycle counts to date, projected out to 60 years of operation, will not exceed the 40 year design number of cycles. In addition, the rates of temperature change during actual transients are less severe than those for the design transients analyzed, so that the actual fatigue usage that is experienced by the components is less than that calculated for a design transient. Finally, bounding EPU conditions were used for all transient definitions and numbers of cycles, even though EPU operation did not apply to the first 35 years of plant operation. Therefore, there is significant margin incorporated in the number of transient cycles used in the EAF analysis, and the projected numbers of cycles used in the EAF analyses are conservative. Id.

**D. Water Chemistry Program**

40.L Entergy has entered a new action item into its Licensing Research System (LRS) tracking program. The action item reads: "Enhance the existing BWR Water Chemistry program to control dissolved oxygen between 30 ppb to 50 ppb in the reactor feedwater / condensate system." Id. at A18.

40.M Lowering the upper limit of dissolved oxygen in the reactor feedwater / condensate system to 50 ppb will ensure that the actual plant water chemistry conditions are consistent with the values used in the Environmentally Assisted Fatigue analyses. Id.

Respectfully Submitted,



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Dated: June 2, 2008

May 30, 2008

**UNITED STATES OF AMERICA**
**NUCLEAR REGULATORY COMMISSION**

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| 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 SUPPLEMENTAL DECLARATION OF JAMES C. FITZPATRICK AND GARY L. STEVENS ON NEC CONTENTION 2A/ 2B – ENVIRONMENTALLY ASSISTED FATIGUE**

James C. Fitzpatrick and Gary L. Stevens state as follows under penalty of perjury:

1. On May 12, 2008, we prepared our "Testimony of James C. Fitzpatrick and Gary L. Stevens on NEC Contention 2A/2B – Environmentally Assisted Fatigue," which was submitted by Entergy as part of Exhibit E2-01 in the above captioned proceeding.

2. We have now prepared the attached "Supplemental Testimony of James C. Fitzpatrick and Gary L. Stevens on NEC Contention 2A/2B – Environmentally Assisted Fatigue," which supplements our earlier testimony in response to testimony provided by witnesses for other parties herein.

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

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

Executed on May 30, 2008

James C. Fitzpatrick

Gary L. Stevens

Gary L. Stevens

Executed on May 30, 2008

May 30, 2008

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# SUPPLEMENTAL TESTIMONY OF JAMES C. FITZPATRICK AND GARY L. STEVENS ON NEC CONTENTION 2A / 2B – ENVIRONMENTALLY ASSISTED FATIGUE

## I. INTRODUCTION

**James C. Fitzpatrick ("JCF")**

**Q1.** Please state your full name.

**A1.** (JCF) My name is James C. Fitzpatrick.

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

**A2.** (JCF) I am currently employed by AREVA, NP as an Engineering Supervisor. Until March 7, 2008, I was employed by Entergy Nuclear Operations, Inc. ("Entergy") as a Senior Lead Engineer in Design Engineering at the Vermont Yankee Nuclear Power Station ("VY").

**Q3.** Have you previously provided written testimony in this proceeding?

**A3.** (JCF) Yes. I was co-sponsor with Mr. Gary L. Stevens of direct testimony dated May 12, 2008 entitled "Testimony of James C. Fitzpatrick and Gary L. Stevens on NEC

Contention 2A/2B – Environmentally Assisted Fatigue" ("Entergy's Direct Testimony") which was submitted as part of Entergy's Exhibit E2-01.

**Gary L. Stevens ("GLS")**

**Q4.** Please state your full name.

**A4.** (GLS) My name is Gary Lance Stevens.

**Q5.** By whom are you employed and what is your position?

**A5.** (GLS) I am a Senior Associate at Structural Integrity Associates, Inc. ("SIA").

**Q6.** Have you previously provided written testimony in this proceeding?

**A6.** (GLS) Yes. I was co-sponsor with Mr. James C. Fitzpatrick of Entergy's Direct Testimony dated May 12, 2008.

**Q7.** What is the purpose of your supplemental testimony?

**A7.** (JCF, GLS) The purpose of our supplemental testimony is to respond, on behalf of Entergy, to certain materials submitted by the NRC Staff ("Staff") regarding NEC Contentions 2A/2B in this proceeding.

**Q8.** What aspects of the NRC Staff's May 13, 2008 testimony on NEC Contentions 2A/2B will you be addressing in your supplemental testimony?

**A8.** (JCF, GLS) Our supplemental testimony addresses portions of the "Affidavit of Kenneth C. Chang Concerning NEC Contentions 2A & 2B (Metal Fatigue)" dated May 12, 2008, Staff Exhibit 2 ("Chang Affidavit").

## II. DISCUSSION

### A. Overview of Supplemental Testimony

**Q9.** What are the areas covered in the Chang Affidavit as to which you are providing supplemental information?

**A9.** (JCF, GLS) We generally agree with the positions expressed in the Chang affidavit. We believe, however, that additional information and clarifications need to be provided in three areas addressed in the affidavit.

**Q10.** What areas are those?

**A10.** (JCF, GLS) They are: (1) characteristics of the methodology used by Entergy to perform its refined calculations of environmentally assisted fatigue ("EAF") for the plant-specific locations at VY equivalent to those identified in NUREG/CR-6260 for the older vintage General Electric plant; (2) the number of transient cycles used in the VY EAF analyses, which will be tracked by the Fatigue Monitoring Program ("FMP") to be implemented by Entergy during the period of extended operation; and (3) the program for monitoring the water chemistry to be used at VY during the period of extended operation.

### B. Entergy's Refined Analysis Methodology

**Q11.** What areas of Entergy's refined analysis methodology require clarification?

**A11.** (GLS, JCF) Those areas are: First, whether the refined stress analyses performed by Entergy are one-dimensional ("1-D") or three-dimensional; second, whether the refined analysis uses a methodology that conforms to the guidance in the American Society of Mechanical Engineers ("ASME") Code; third, whether the EAF predictions obtained using the refined analysis methodology are appropriately conservative; fourth,

whether the environmentally assisted fatigue predictions for the recirculation outlet nozzle and the core spray nozzle obtained using the refined analyses are conservative and reliable, and fifth, whether the choice of location for the analysis of the stresses on the feedwater, recirculation outlet, and core spray nozzle was appropriate.

**Q12.** Are the refined stress analyses performed by Entergy one-dimensional or three-dimensional?

**A12.** (GLS) The finite element models used for all of the VY refined analyses and the confirmatory analysis are axisymmetric and provide detailed, three-dimensional stress results. Thus, the "1-D" designation does not refer to the geometric modeling of the component, which is three-dimensional, but rather refers to an analytical simplification that was used to approximate all six stress components with a single stress term.

**Q13.** Does the refined analysis performed by Entergy conform to the guidance in the ASME Code?

**A13.** (GLS) Yes. The Chang Affidavit at A16 agrees that the confirmatory analysis of the feedwater nozzle performed by Entergy at the NRC Staff's request (Exhibits E2-25 through E2-27) was conducted in accordance with the methodology set forth in ASME Code Subsection NB, Subarticle NB-3200, but implies that the refined analyses do not conform to the guidance in that section of the ASME Code. In reality, all of the refined analyses and the confirmatory analysis performed by Entergy were conducted in accordance with the methodology set forth in ASME Code Subsection NB, Subarticle NB-3200. That methodology is not prescriptive. As a result, all analyses performed using the ASME Code

methodology rely to a degree on the judgment of the analyst on items such as stress component simplification, transient definitions, heat transfer coefficients, material properties, and other input parameters to ensure that the analysis results are appropriate and bounding for the intended application. The single stress term simplification discussed previously is appropriate and conservative and the use of such a simplification is consistent with the ASME Code Section III fatigue calculation methodology. In fact, the refined analyses performed for the VY nozzle components use many of the same judgments that have been routinely applied in current licensing basis analyses historically performed throughout the industry for Class 1 components that have used ASME Code, Subsection NB, Subarticle NB-3200 methodology.

**Q14.** Why are the environmentally assisted fatigue calculations obtained using the refined analysis methodology appropriately conservative?

**A14.** (GLS) The $CUF_{en}$ at the feedwater nozzle corner was calculated to be 0.63 in the refined analysis. This value is higher than the $CUF_{en}$ value of 0.35 calculated at the feedwater nozzle corner in the confirmatory analysis. Whereas the CUF value, prior to adjustment for environmental effects, was higher for the confirmatory analysis than for the refined analysis, the higher value of CUF in the confirmatory analysis was the result of the different implicit conservatisms incorporated in each analysis. That one conservative analysis is slightly higher than another does not render the first nonconservative (and indeed, it would be surprising if they were identical). When these differences are all collectively considered in each evaluation performed, the refined analysis methodology used

by Entergy remains conservative, as demonstrated by the final $CUF_{en}$ results.

**Q15.** Why are the environmentally assisted fatigue predictions for the recirculation outlet nozzle and the core spray nozzle obtained using the refined analyses conservative and reliable?

**A15.** (GLS) The refined analyses for all three nozzles were performed using consistent methodologies and conservative analytical judgments. Therefore, it follows that if all of the same methodologies and analytical judgments are applied to the recirculation outlet and core spray nozzles as were applied to the feedwater nozzle, similar trends in $CUF_{en}$ values will result. Based on the results obtained from the two analyses performed for the feedwater nozzle, as just discussed, the results of the refined analyses for the recirculation outlet and core spray nozzles are also conservative.

**Q16.** Is there any doubt as to the appropriateness of the locations chosen for conducting the analyses of the feedwater, recirculation outlet and core spray nozzles?

**A16.** (GLS, JCF) No. As indicated in the Chang Affidavit at A8, the Staff had some initial questions as to the choice of physical location for the performance of the stress analyses of these three nozzles. However, for the safe end of each nozzle where thermal stresses are controlling, Entergy explained that the evaluated location was selected as the location of maximum thermal stress for a bounding 500°F to 100°F temperature step transient at 100% flow conditions. For the "nozzle corner" (blend radius) of each nozzle where pressure stresses are controlling, the evaluated location was selected as the location of maximum stress due to internal pressure. These selections of controlling locations were used

throughout all of the VY analyses, including the confirmatory analyses of the feedwater nozzle corner, and were identified as such in the analyses.

### C. Transient Cycle Projections

**Q17.** Mr. Fitzpatrick, would you please describe how the number of transient cycles included in the VY EAF analysis was obtained, and how they relate to actual plant cycles?

**A17.** (JCF) The Chang Affidavit describes in general terms (at A10, A27 and A28) how the cycle counting aspects of the Fatigue Management Program that will be implemented by Entergy during the period of extended operation after license renewal will insure the number of transient cycles experienced by VY does not exceed the assumed number of transients used in the fatigue analyses.

Dr. Chang indicates, however, (at A10) that the Staff cannot determine the level of conservatism inherent in the estimated number of transients used in the EAF analysis. The following additional information shows that the number of transient cycles that are estimated to be experienced at VY as part of the EAF analysis is conservative.

To insure a realistic projection for the thermal transient cycles and events expected for 60 years of operation, the Thermal Cycle Diagrams from a later vintage BWR were used as a starting point. The VY Design Specification transients were mapped onto the BWR Transient Diagrams. Then, projections for 60 years were made based on the numbers for 40 years in the VY Design Specification, the numbers actually analyzed in the VY Design Stress Report, and the number of cycles experienced by VY in

approximately 35 years of operation. For example, 200 Startup / Shutdown cycles were included in the original VY Design Specification. However, 300 Startup / Shutdown cycles were conservatively used in the EAF analyses for 60 years of operation.

The following considerations demonstrate the conservative nature of the EAF cycle projections:

- The 60 year projections of operating events used in the VY EAF analyses are equal or greater in number to the numbers of cycles in the original VY Design Specification for 40 years, with one minor exception.

- Actual plant cycle counts to date, projected out to 60 years of operation, will not exceed the 40 year design number of cycles.

- The rates of temperature change during actual transients are less severe than those for the design transients analyzed, so that the actual fatigue usage that is experienced by the components is less than that calculated for a design transient.

- Bounding EPU conditions were used for all transient definitions and numbers of cycles, even though EPU operation did not apply to the first 35 years of plant operation.

Therefore, there is significant margin incorporated in the number of transient cycles used in the EAF analysis.

There is one minor exception to the first of the statements listed above. For one event, Improper Start of a Cold

Recirculation Loop, five events were included in the original VY Design Specification and one event was evaluated in the EAF analysis. (This event applies only to the recirculation outlet nozzle.) Evaluation of the recirculation outlet nozzle using one Improper Start event is justified because the event can only occur during low power operation with one recirculation loop in service and the idle loop allowed to cool down. Continuous operation at low power levels is a rare occurrence and the Improper Start event, as described by the EAF analysis transient definition, is prohibited by the VY technical specifications. Inclusion of one event in the EAF analysis therefore accounts for the improbable situation in which one of these events occurs.

For the reasons stated above, the projected numbers of cycles used in the EAF analyses are conservative.

**D. Water Chemistry Program**

**Q18.** What program will be used at VY to monitor the water chemistry used at the plant?

**A18.** (JCF) The Chang Affidavit (at A11) makes reference to the Water Chemistry Program that will be utilized at VY during the period of extended operations after license renewal. The following additional information about the FMP is relevant. Entergy has informed me that it has entered a new action item into its Licensing Research System (LRS) tracking program. The action item reads:

> Enhance the existing BWR Water Chemistry program to control dissolved oxygen between 30 ppb to 50 ppb in the reactor feedwater / condensate system.

The existing program limits for feedwater /condensate dissolved oxygen are between 30 and 200 ppb. Lowering the upper limit to 50 ppb will ensure that the actual plant water chemistry conditions are consistent with the values used in the Environmentally Assisted Fatigue analyses.

**Q19.** Does that conclude your testimony?

**A19.** (JCF, GLS) Yes, it does.

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## CERTIFICATE OF SERVICE

I hereby certify that copies of "Entergy's Supplemental Statement of Position on New England Coalition Contentions 2A/2B" and "Joint Supplemental Declaration of James C. Fitzpatrick and Gary L. Stevens on NEC Contentions 2A and 2B – Environmentally Assisted Fatigue" were served on the persons listed below by deposit in the U.S. Mail, first class, postage prepaid, and where indicated by an asterisk by electronic mail, this 2nd day of June, 2008.

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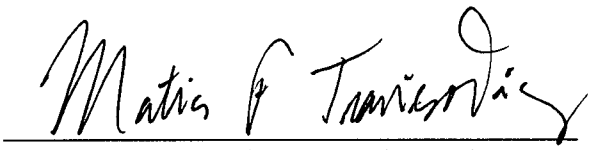

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