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SHEMS DUNKIEL KASSEL & SAUNDERS PLLC

RONALD A. SHEMS*
BRIAN S. DUNKIEL**
JOHN B. KASSEL
MARK A. SAUNDERS
ANDREW N. RAUBVOGEL

GEOFFREY H. HAND
KAREN L. TYLER
REBECCA E. BOUCHER
ASSOCIATE ATTORNEYS
EILEEN I. ELLIOTT
OF COUNSEL

DOCKETED
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April 29, 2008 (8:00am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

April 28, 2008

Office of the Secretary
Attn: Rulemaking and Adjudications Staff
Mail Stop O-16C1
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: 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
Filing Attaching and Discussing Proprietary Documents

Dear Sir or Madam:

Please find enclosed for filing in the above-stated matter New England Coalition, Inc.'s Statement of Position, Direct Testimony and Exhibits. Four documents that Entergy has designated proprietary are included in this filing as Exhibits NEC-JH_38, NEC-UW_08, NEC-UW_16, and NEC-UW_17. Some of these documents are also discussed in the direct testimony of Dr. Joram Hopenfeld, Exhibit NEC-JH_01, and two expert witness reports, Exhibits NEC-JH_36 and NEC-UW_03. These documents are:

1. Recommendations for an Effective Flow-Accelerated Corrosion Program (NSAC-202L-R3);

2. EPRI: Recommendations for FAC Tasks;

3. Letter to James Fitzpatrick from EPRI (February 28, 2000); and

4. Letter from Entergy to NRC re. Extended Power Uprate: Response to Request for Additional Information.

The first two documents are EPRI guidance documents for flow-accelerated corrosion programs. The third is a letter to an Entergy staff person at the Vermont Yankee (VY) plant, stating EPRI's evaluation of the VY FAC program, and recommending certain changes to that program. The fourth is Entergy's response to a NRC Staff Request for Additional Information concerning issues related to Entergy's VYNPS EPU application.

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Pursuant to the Protective Order governing this proceeding, an unredacted version of this filing, including the four proprietary documents, will be served only on the Board, the NRC's Office of the Secretary, Entergy's Counsel, and the following persons who have signed the Protective Agreement: Sarah Hoffman and Anthony Roisman. A redacted version of this filling that does not include the proprietary documents will be served on all other parties.

Thank you for your attention to this matter.

Sincerely,

Karen Tyler

Karen Tyler
SHEMS DUNKIEL KASSEL & SAUNDERS PLLC

Cc: attached service list

NEW ENGLAND COALITION, INC.'S LIST
OF PREFILED DIRECT TESTIMONY AND EXHIBITS

Exhibit Number	Name of Exhibit
NEC-JH_01	Prefiled Testimony of Joram Hopenfeld
NEC-JH_02	Curriculum Vitae of Joram Hopenfeld
NEC-JH_03	Joram Hopenfeld, "Review of Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. ("Entergy") Analyses of the Effects of Reactor Water Environment on Fatigue Life of Risk-Significant Components During the Period of Extended Operation" (April 21, 2008).
NEC-JH_04	Structural Integrity Associates ("SIA"), "VY-16Q-301: Feedwater Nozzle Stress History Development for Green Functions" (July 12, 2007).
NEC-JH_05	SIA, "VY-16Q-302: Fatigue Analysis of Feedwater Nozzle" (July 18, 2007).
NEC-JH_06	SIA, "VY-16Q-303: Environmental Fatigue Evaluation of Reactor Recirculation Inlet Nozzle and Vessel Shell/Bottom Head" (July 5, 2007).
NEC-JH_07	SIA, "VY-16Q-304: Recirculation Outlet Nozzle Finite Element Model" (July 12, 2007).
NEC-JH_08	SIA, "VY-16Q-305: Recirculation Outlet Stress History Development for Nozzle Green Function" (July 18, 2007).
NEC-JH_09	SIA, "VY-16Q-306: Fatigue Analysis of Recirculation Outlet Nozzle" (July 27, 2007).
NEC-JH_10	SIA, "VY-16Q-307: Recirculation Class 1 Piping Fatigue and EAF Analysis" (July 27, 2007).
NEC-JH_11	SIA, "VY-16Q-308: Core Spray Nozzle Finite Element Model" (July 19, 2007).
NEC-JH_12	SIA, "VY-16Q-309: Core Spray Nozzle Green's Functions" (July 20, 2007).
NEC-JH_13	SIA, "VY-16Q-310: Fatigue Analysis of Core Spray Nozzle" (July 26, 2007).

NEC-JH_14	SIA, "VY-16Q-311: Feedwater Class 1 Piping Fatigue Analysis" (July 20, 2007).
NEC-JH_15	SIA, "VY-16Q-401: Environmental Fatigue Analysis for the Vermont Yankee Reactor Pressure Vessel Feedwater Nozzles" (July 26, 2007).
NEC-JH_16	SIA, "VY-16Q-402: Environmental Fatigue Analysis for the Vermont Yankee Reactor Pressure Vessel Reactor Recirculation Outlet Nozzle" (July 26, 2007).
NEC-JH_17	SIA, "VY-16Q-403: Environmental Fatigue Analysis for the Vermont Yankee Reactor Pressure Vessel Core Spray Nozzle" (July 26, 2007).
NEC-JH_18	SIA, "VY-16Q-404: Summary Report of Plant-Specific Environmental Fatigue Analyses for the Vermont Yankee Nuclear Power Station" (December 15, 2007).
NEC-JH_19	SIA, "VY-19Q-301: Design Inputs and Methodology for ASME Code Confirmatory Fatigue Usage Analysis of Reactor Feedwater Nozzle" (January 29, 2008).
NEC-JH_20	SIA, "VY-19Q-302: ASME Code Confirmatory Fatigue Evaluation of Reactor Feedwater Nozzle" (January 30, 2008).
NEC-JH_21	SIA, "VY-19Q-303: Feedwater Nozzle Environmental Fatigue Evaluation" (January 30, 2008).
NEC-JH_22	NRC Staff Memorandum: "Summary of Meeting Held on January 8, 2008 between the U.S. Nuclear Regulatory Commission Staff and Entergy Nuclear Operations, Inc. Representatives to Discuss the Response to a Request for Additional Information Pertaining to the Vermont Yankee Nuclear Power Station License Renewal Application."
NEC-JH_23	NRC, "NRC Regulatory Issue Summary 2008-10 Fatigue Analysis of Nuclear Power Plan Components" (April 11, 2008).
NEC-JH_24	NRC, "Notification of Information in the Matter of Oyster Creek Nuclear Generating Station License Renewal Application" (April 3, 2008).
NEC-JH_25	Drawing 5920-624: Reactor 8IN DIA Nozzle MK N5A & B
NEC-JH_26	Argonne National Laboratory, *Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials*, ANL-06/08, NUREG/CR-6909 (February, 2007).

NEC-JH_27	NRC, Transcript of Advisory Committee on Reactor Safeguards ("ACRS") Subcommittee on Materials, Metallurgy and Reactor Fuels (December 6, 2006).
NEC-JH_28	NRC, Official Transcript, ACRS 549th Meeting (Feburary 7, 2008).
NEC-JH_29	E.R.G. Eckert and R. Drake, *Heat and Mass Transfer* 212 (2nd ed. 1959).
NEC-JH_30	H. Schlichting, *Boundary Layer Theory* 555 (J. Kestin trans., 4th ed.. 1960).
NEC-JH_31	J.P. Holman, *Heat Transfer* 226, 413 (5th ed. 1981).
NEC-JH_32	Vermont Yankee Nuclear Power Corporation, "Vermont Yankee 2001 Summary Reports for In-Service Inspection and Repairs or Replacements" (August 20, 2001).
NEC-JH_33	Entergy, "License Renewal Application, Amendment 35" (Feburary 5, 2008).
NEC-JH_34	Entergy, "License Renewal Application, Amendment 34" (January 30, 2008).
NEC-JH_35	NRC, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 229 to Facility Operating License No. DPR-28: Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. Vermont Yankee Nuclear Power Station, Docket No. 50-271."
NEC-JH_36	Joram Hopenfeld, Review of License Renewal Application for Vermont Yankee Nuclear Power Station: Program for Management of Flow-Accelerated Corrosion (April 24, 2008).
NEC-JH_37	EPRI, "Tackling the Single-Phase Erosion Corrosion Issue" (April 18, 1988).
NEC-JH_38	EPRI, "Recommendations for an Effective Flow-Accelerated Corrosion Program (NSAC-202L-R3)" (May 2006). [PROPRIETARY]
NEC-JH_39	NRC, Transcript of ACRS Thermal Hydraulic Phenomena Subcommittee (January 26, 2005).
NEC-JH_40	Y. M. Ferng et al., "A New Approach for Investigation of Erosion-Corrosion Using Local Flow Models," 55 *Corrosion* No. 4, 332-42 (April 1999).

NEC-JH_41	Portland General Electric Co., "Secondary Piping Erosion/Corrosion" (July 31, 1987).
NEC-JH_42	"VY Piping FAC Inspection Program PP7028 – 2007 Refueling Outage: Inspection Location Worksheets/Methods and Reasons for Component Selection" (May 11, 2006).
NEC-JH_43	"PP 7028 FAC Inspections 2004 Refueling Outage."
NEC-JH_44	Entergy, "Focused Self-Assessment Report: Vermont Yankee Piping Flow Accelerated Corrosion Inspection Program" (October 28, 2004).
NEC-JH_45	NRC, "NRC Information Notice 2001-09: Main Feedwater System Degradation in Safety-Related ASME Code Class 2 Piping Inside the Containment of a Pressurized Water Reactor" (June 12, 2001).
NEC-JH_46	NRC, "NRC Information Notice 91-19: Steam Generator Feedwater Distribution Piping Damage" (March 12, 1991).
NEC-JH_47	NRC, "NRC Information Notice 91-18: High-Energy Piping Failures Caused by Wall Thinning" (March 12, 1991).
NEC-JH_48	NRC, "NRC Information Notice 92-35: Higher than Predicted Erosion/Corrosion in Unisolable Reactor Coolant Pressure Boundary Piping Inside Containment at a Boiling Water Reactor" (May 6, 1992).
NEC-JH_49	NRC, "NRC Information Notice 93-06: Potential Bypass Leakage Paths Around Filters Installed in Ventilation Systems" (January 22, 1993).
NEC-JH_50	NRC, "NRC Information Notice 95-11: Failure of Condensate Piping Because of Erosion/Corrosion at a Flow-Straightening Device" (February 24, 1995).
NEC-JH_51	NRC, "NRC Information Notice 97-84: Rupture in Extraction Steam Piping as a Result of Flow-Accelerated Corrosion" (December 11, 1997).
NEC-JH_52	NRC, "Kewaunee 3Q/2006 Plant Inspection Findings" (December 21, 2006).
NEC-JH_53	Nuclear and Industrial Safety Agency, "Interim Summary on Secondary Piping Rupture Accident at Mihama Power Station, Unit 3 of the Kansai Electric Power Co., Inc." (September 27, 2004)

NEC-JH_54	Joram Hopenfeld, "Assessment of Proposed Program to Manage Aging of the Vermont Yankee Steam Dryer Due to Flow-Induced Vibrations" (April 25, 2008).
NEC-JH_55	GE Nuclear Energy, "BWR Steam Dryer Integrity," SIL No. 644, Revision 1 (November 9, 2004).
NEC-JH_56	NRC, "NRC Information Notice 2002-26, Supplement 2: Additional Flow-Induced Vibration Failures After a Recent Power Uprate" (January 9, 2004).
NEC-JH_57	Email from Rick Ennis, "FWD: VY Steam Dryer Crack Info" (April 16, 2004).
NEC-JH_58	NRC, "Vermont Yankee Nuclear Power Station – NRC Integrated Inspection Report 05000271/200403" (July 26, 2004).
NEC-JH_59	Entergy, "Condition Report," CR-VTY-2007-02133 (May 28, 2007).
NEC-JH_60	Vermont Public Service Board Docket Number 7195, Excerpt from Transcript of Technical Hearing re: Reliability of Steam Dryer and Resulting Perofrmance of VT Yankee Under Uprate Conditions (August 18, 2006).
NEC-JH_61	Declaration of John R. Hoffman in Support of Entergy's Motion for Summary Disposition of NEC Contention 3 (April 18, 2007).
NEC-JH_62	NRC, "Summary of Telephone Conference Call Held on August 20, 2007, between the U.S. Nuclear Regulatory Commission and Entergy Nuclear Operations, Inc., Concerning the Vermont Yankee Nuclear Power Station License Renewal Application" (October 25, 2007).
NEC-RH_01	Prefiled Testimony of Rudolf Hausler
NEC-RH_02	Curriculum Vitae of Rudolf Hausler
NEC-RH_03	Rudolf Hausler, "Discussion of the Empirical Modeling of Flow-Induced Localized Corrosion of Steel under High Shear Stress" (April 25, 2008).
NEC-UW_01	Prefiled Testimony of Ulrich Witte
NEC-UW_02	Curriculum Vitae of Ulrich Witte
NEC-UW_03	Ulrich Witte, "Evaluation of Vermont Yankee Nuclear Power Station License Extension: Proposed Again Management Program for Flow Accelerated Corrosion" (April 25, 2008).

NEC-UW_04	NRC, "Clinton Power Station NRC Inspection Report 50-461/02-10(DRS)" (January 24, 2003).
NEC-UW_05	NRC, "Generic Aging Lessons Learned (GALL) Report: Tabulation of Results," NUREG-1801, Vol. 2, Rev. 1 (September 2005).
NEC-UW_06	"Verification of VYNPS License Renewal Project Report: Aging Management Program Evaluation Results," Report # LRPD-02 (May 9, 2006).
NEC-UW_07	VT Yankee, "Cornerstone Rollup: Flow Accelerated Corrosion" (October 3, 2006).
NEC-UW_08	Letter from Douglas Munson to James Fitzpatrick re: Review of the Vermont Yankee Nuclear Plant Flow-Accelerated Corrosion Program (February 28, 2000). [PROPRIETARY]
NEC-UW_09	Entergy Quality Assurance Division, "Engineering Programs," Audit No. QA-8-2004-VY-1 (November 22, 2004).
NEC-UW_10	Entergy, "Condition Report: CHECWORKS predictive models for Piping FAC Inspection Program not updated as required per Appendix D of PP7028," CR-VTY-2005-02239 (July 28, 2005).
NEC-UW_11	NRC, Official Transcript of ACRS Subcommittee on Plant License Renewal (June 5, 2007).
NEC-UW_12	Entergy, "Nuclear Management Manual: Flow Accelerated Corrosion Program" (March 9, 2006).
NEC-UW_13	Chockie Group International, "Aging Management and Life Extension in the US Nuclear Power Industry" (October 2006).
NEC-UW_14	Email from Beth Sienel to Jonathan Rowley, "re: Update to CHECWORKS" (Feburary 20, 2008).
NEC-UW_15	L.E. Hochreiter, "Data Collection of Pipe Failures Occurring in Stainless Steel and Carbon Steel Piping," NucE 597D – Project 1 (April 2005).
NEC-UW_16	EPRI, "Chapter 4: Recommendations for FAC Tasks" [PROPRIETARY]
NEC-UW_17	Entergy, Letter to NRC re: Extended Power Uprate: Response to Request for Additional Information (July 2, 2004). [PROPRIETARY]
NEC-UW_18	Union of Concerned Scientists, "Power Uprate History"

NEC-UW_19	Vermont Yankee Nuclear Power Station, "PP7028: Piping Flow Accelerated Corrosion Inspection Program" (May 10, 2001).
NEC-UW_20	Vermont Yankee Nuclear Power Station, "PP7028: Piping FAC Inspection Program – FAC Inspection Program Records for 2005 Refueling Outage."
NEC-UW_21	Betsy Thatcher, "Second Victim Dies of Burns from Power Plant Explosion," Milwaukee Sentinel, March 9, 1995.
NEC-UW_22	NRC, "Issue 139: Thinning of Carbon Steel Piping in LWRs (Rev. 1)" (February 23, 2007).

UNITED STATES
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)	)	

NEW ENGLAND COALITION, INC
INITIAL STATEMENT OF POSITION

In accordance with 10 C.F.R. § 2.1207(a)(1) and the Atomic Safety and Licensing Board's ("Board") November 17, 2006 Order,[1] New England Coalition, Inc. ("NEC") hereby submits its Initial Statement of Position ("Statement") on NEC's Contentions 2A and 2B (environmentally-assisted metal fatigue analysis), 3 (steam dryer), and 4 (flow-accelerated corrosion). In support of this Statement, NEC submits the attached direct testimony of Dr. Joram Hopenfeld,[2] Dr. Rudolf Hausler,[3] and Mr. Ulrich Witte[4] and the additional Exhibits listed on the attached Exhibit List.

[1] Licensing Board Order (Initial Scheduling Order) (Nov. 17, 2006) at 9-11 (unpublished).

[2] Exhibit NEC-JH_01.

[3] Exhibit NEC-RH_01.

[4] Exhibit NEC-UW_01.

Section I of this Statement sets forth the Nuclear Regulatory Commission ("NRC") legal standards that govern the Atomic Safety and Licensing Board's ("the Board") determination of NEC's Contentions in this license renewal proceeding. Section II states NEC's position and outlines NEC's evidence regarding Contentions 2A and 2B (environmentally-assisted metal fatigue). Section III states NEC's position and outlines NEC's evidence regarding Contention 3 (steam dryer). Section IV states NEC's position and outlines NEC's evidence regarding Contention 4 (flow-accelerated corrosion).

I. LEGAL STANDARDS.

Operating licenses may only be renewed if the NRC finds that the license requirements are "in accord with the common defense and security and will provide adequate protection to the health and safety of the public." 42 U.S.C. § 2232(a). As the Commission explained, "[t]he license renewal review is intended to identify any additional actions that will be needed to maintain the functionality of the systems, structures, and components in the period of extended operation." Final Rule, Nuclear Power Plant License Renewal; Revisions, 60 Fed. Reg. 22461, 22646 (May 8, 1995).

The standard governing the issuance of renewed licenses for operating commercial nuclear power plants are set forth in 10 C.F.R. §§ 54.21 and 54.29. Pursuant to these rules, license renewal proceedings review: (1) "the plant structures and components that will require an aging management review for the period of extended operation," and (2) "the plant's systems, structures, and components that are subject to an evaluation of time-limited aging analyses." *Duke Energy Corp. (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2)*, CLI-01-20, 54 NRC 211, 212 (2001).

A. Time-Limited Aging Analyses ("TLAA): NEC Contentions 2A and 2B.

NEC's Contentions 2A and 2B question the validity of a time-limited aging analysis ("TLAA"): Entergy's[5] assessment of the impact of environmentally-assisted metal fatigue[6] on risk-significant Vermont Yankee Nuclear Power Station (VYNPS) components during the period of extended operation.[7] By this analysis, Entergy attempts to demonstrate that vulnerable components will meet the ASME Code acceptance criteria, which is cumulative usage factor[8] ("CUF") less than one, throughout the period of extended plant operations.

NRC regulation 10 CFR § 54.21(c) requires that each license renewal application include "an evaluation of time-limited aging analyses" ("TLAA") for components covered by the license renewal regulations.[9] If the applicant is unable to demonstrate that

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[5] "Entergy" refers to the license renewal Applicant, Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc.

[6] "Fatigue" is defined as an age-related degradation mechanism caused by cyclic stressing of a component by either mechanical or thermal stresses that eventually cause the component to crack. Exhibit NEC-JH_03 at 22.

[7] *See,* Exhibit NEC-JH_62, NRC Summary of Telephone Conference Call Held on August 20, 2007, Between the U.S. Nuclear Regulatory Commission and Entergy Nuclear Operations, Inc., Concerning the Vermont Yankee Nuclear Power Station License Renewal Application at Enclosure 2 ("Fatigue analyses based on a set of design transients and on the life of the plant are treated as TLAAs.").

[8] "Cumulative Usage Factor" is defined as a summation of usage fatigue factors. "Usage Fatigue Factor" is defined as the number of cycles n at any given stress amplitude divided by the corresponding number of cycles to end of life, N. Exhibit NEC-JH_03 at 22.

[9] TLAAs are defined in 10 C.F.R. § 54.3 (a) as:

> Those licensee calculations and analyses that:
>
> (1) Involve systems, structures, and components within the scope of license renewal, as delineated in § 54.4(a);
> (2) Consider the effects of aging;
> (3) Involve time-limited assumptions defined by the current operating term, for example, 40 years;
> (4) Were determined to be relevant by the licensee in making a safety determination;

TLAAs "remain valid for the period of extended operation" or that they "have been projected to the end of the period of extended operation," it must demonstrate that "the effects of aging on the intended function(s) will be adequately managed for the period of extended operation." 10 C.F.R. 54.21(c)(1)(i)-(iii).

NRC regulation 10 CFR § 54.29 authorizes the NRC to issue a renewed license only if it finds that "there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the [current licensing basis]."[10] 10 CFR § 54.29. Taken together as they apply to NEC's Contentions 2A and 2B, Sections 54.21(c) and 54.29 require Entergy to demonstrate that its environmentally-assisted metal fatigue analysis provides "reasonable assurance" that vulnerable plant components will meet the acceptance criteria (CUF less than one) during the period of extended operations.[11]

> (5) Involve conclusions or provide the basis for conclusions related to the capability of the system, structure and component to perform its intended functions, as delineated in § 54.4(b); and
> (6) Are contained or incorporated by reference in the CLB [current licensing basis].

[10] The CLB is defined in 10 C.F.R. § 54.3 as:

"the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect. The CLB includes the NRC regulations contained in 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 54, 55, 70, 72, 73, 100 and appendices thereto; orders; license conditions; exemptions; and technical specifications. It also includes the plant-specific design-basis information defined in 10 CFR 50.2 as documented in the most recent final safety analysis report (FSAR) as required by 10 CFR 50.71 and the licensee's commitments remaining in effect that were made in docketed licensing correspondence such as licensee responses to NRC bulletins, generic letters, and enforcement actions, as well as licensee commitments documented in NRC safety evaluations or licensee event reports."

Thus, the CLB incorporates requirements of the license and certain other documents, such as the FSAR and formal commitments made in licensing correspondence.

[11] Both the Federal Courts and the Commission have recognized that "reasonable assurance" refers to the required degree of assurance that the "adequate protection" standard contained in the Atomic Energy Act, 42

NUREG-1801, Rev. 1, Generic Aging Lessons Learned (GALL) Report (2005) ("NUREG-1801") provides guidance for the preparation of TLAAs specifically with respect to environmentally-assisted metal fatigue.[12] NUREG-1801 advises that a license renewal applicant may address "the effects of the coolant environment on component fatigue life by assessing the impacts of the reactor coolant environment on a sample of critical components for the plant." NUREG-1801, Vol. 2 at X M-1. Examples of critical components are identified in NUREG/CR-6260, Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components (1995). The sample of critical components "can be evaluated by applying environmental life correction factors to the existing ASME Code fatigue analyses." NUREG-1801, Vol. 2 at X M-1. If these components are found not to comply with the ASME Code acceptance criteria, CUF less than one with the environmental correction factor applied, "corrective actions" must be taken that "include a review of additional affected reactor coolant pressure boundary locations." Id. at X M-2. As explained further in industry guidance document MRP-47:

> The locations evaluated in NUREG/CR-6260 [2] for the appropriate vendor/vintage plant should be evaluated on a plant-unique basis. For cases where acceptable fatigue results are demonstrated for these locations for 60 years of plant operation including environmental effects, additional evaluation or locations need not be considered. However, plant-unique evaluations may show that some of the NUREG/CR-6260 [2] locations do not remain within allowable limits for 60 years of plant operation when environmental effects are considered. In this situation, plant specific evaluations should expand the sampling of locations accordingly to include other locations where high usage factors might be a concern.

U.S.C. § 2232(a), is satisfied. *Commonwealth Edison Co. (Zion Units 1 and 2), ALAB-616, 12 NRC 419, 421 (1980).*

[12] NUREG-1801 is referenced with approval in Regulatory Guide 1.188, Rev. 1, *Standard Format and Content for Applications to Renew Nuclear Power Plant Operating Licenses* (2005) ("Reg. Guide 1.188").

MRP-47, Revision 1, Electric Power Research Institute, *Materials Reliability Program: Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application* at 3-4 (2005).

In August, 2007, the NRC Staff took the position with respect to Entergy's License Renewal Application (LRA) for VYNPS that, to meet the requirements of 10 CFR § 54.21(c)(1), Entergy must demonstrate in its LRA that its environmentally-assisted metal fatigue analysis has been completed, and cannot rely on a commitment to complete this analysis prior to entering the period of extended operation. The NRC's view of this important issue is set forth in correspondence attached hereto as Exhibit NEC-JH_62:

> It is the NRC position that in order to meet the requirements of 10 CFR § 54.21(c)(1), an applicant for license renewal must demonstrate in the LRA that the evaluation of the time-limited aging analyses (TLAA) has been completed. The NRC does not accept a commitment to complete the evaluation of TLAA prior to entering the period of extended operation.
>
> Fatigue analyses based on a set of design transients and on the life of the plant are treated as TLAAs. The applicant made a commitment (license renewal Commitment #27) to address environmentally assisted fatigue by refining fatigue analyses to include the effects of reactor water environment to verify that the cumulative usage factors are less than 1.0. The NRC could not accept this commitment.
>
> [T]he applicant agreed to amend its LRA to demonstrate that the evaluation of the TLAA has been completed. The NRC's review of this TLAA evaluation will be documented in the final VYNPS safety evaluation report.

NRC Summary of Telephone Conference Call Held on August 20, 2007, Between the U.S. Nuclear Regulatory Commission and Entergy Nuclear Operations, Inc., Concerning the Vermont Yankee Nuclear Power Station License Renewal Application (October 25, 2007), Exhibit NEC-JH_62 at Enclosure 2.

B. Aging Management Review: NEC Contentions 3 and 4.

License renewal applicants must "demonstrate how their [aging management] programs will be effective in managing the effects of aging during the period of extended operation." *Florida Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 & 4)*, CLI-01-17, 54 NRC 3, 8 (2001). NEC's Contentions 3 (steam dryer) and 4 (flow-accelerated corrosion) both address Entergy's compliance with this requirement. Contention 3 is that the LRA does not include an adequate plan to monitor and manage aging of the VYNPS steam dryer. Contention 4 is that the LRA does not include an adequate plan to monitor and manage aging of plant equipment due to flow-accelerated corrosion ("FAC").[13]

NRC regulation 10 C.F.R. § 54.21 requires Entergy to "demonstrate that the effects of aging will be adequately managed so that [structures and components subject to aging management review] will be maintained consistent with the CLB for the period of extended operation."[14] NRC regulation 10 C.F.R. § 54.29 requires Entergy to identify and take (or plan to take) actions to manage the effects of aging "such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the CLB . . . .".[15] Taken together as they relate to NEC's Contentions 3 and 4, these regulations require Entergy to establish:

1. An aging management program adequate to provide reasonable assurance that the steam dryer will be maintained in accordance with the CLB throughout the twenty-year period of extended operation; and

[13] "Flow accelerated corrosion" is defined as "a physical phenomenon in which metal dissolution is accelerated by fluid flow." Exhibit NEC-JH_36 at 1.

[14] 10 C.F.R. § 54.21(a)(3).

[15] 10 C.F.R. § 54.29(a).

2. An aging management program adequate to provide reasonable assurance that, consistent with the CLB, the minimum wall thickness of plant equipment vulnerable to flow-accelerated corrosion (FAC) will not be reduced by FAC to below ASME code limits throughout the twenty-year period of extended operations.

C. Burden of Proof

In an operating license proceeding, the licensee bears the ultimate burden of proof. *Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1)*, ALAB-697, 16 NRC 1265, 1271 (1982), *citing* 10 C.F.R. § 2.325. Here, it is Entergy's burden to demonstrate by a preponderance of the evidence that its steam dryer aging management program, flow-accelerated corrosion management program, and environmentally-assisted fatigue analysis each provide "reasonable assurance" that the CLB will be maintained during the period of extended operation. *Commonwealth Edison Co. (Zion Units 1 and 2), ALAB-616, 12 NRC 419, 421 (1980)*(Applicants have to "provide 'reasonable assurance' that public health, safety, and environmental concerns were protected, and to demonstrate that assurance by 'a preponderance of the evidence.'").

II. NEC CONTENTIONS 2A AND 2B (Environmentally-Assisted Metal Fatigue Analysis)

A. Procedural History

The VYNPS License Renewal Application (LRA) Table 4.3-3 summarizes Entergy's evaluation of the effects of reactor water environment on the fatigue life of nine components for the period of extended operations. These components correspond to the limiting locations identified in NUREG/CR-6260. Safety Evaluation Report Related to the License Renewal of Vermont Yankee Nuclear Power Station (February

2008)("FSER"), Exhibit NRC Staff_01 at 4-32.[16] LRA Table 4.3-3 states that the environmentally corrected Cumulative Usage Factor (CUFen) of the following risk-significant reactor components will exceed unity (are greater than one): feedwater nozzle, RR inlet nozzle, RR outlet nozzle, RR piping tee, core spray nozzles, core spray safe end, and feedwater piping.

To address this problem, Entergy initially proposed the following in the LRA:

> Prior to entering the period of extended operation, for each location that may exceed a CUF of 1.0 when considering environmental effects, VYNPS will implement one or more of the following:
>
> (1) further refinement of the fatigue analyses to lower the predicted CUFs to less than 1.0;
>
> (2) management of fatigue at the affected locations by an inspection program that has been reviewed and approved by the NRC (e.g., periodic non-destructive examination of the affected locations at inspection intervals to be determined by a method acceptable to the NRC);
>
> (3) repair or replacement of the affected locations.
>
> Should VYNPS select the option to manage environmentally-assisted fatigue during the period of extended operation, details of the aging management program such as scope, qualification, method, and frequency will be provided to the NRC prior to the period of extended operation.
>
> The effects of environmentally-assisted thermal fatigue for the limiting locations identified in NUREG-6260 have been evaluated. Cracking by environmentally-assisted fatigue of these locations is addressed using one of the above three approaches in accordance with 10 CFR 54.21(c)(1).

LRA at 4.3-7.

[16] The Board has requested that the NRC Staff offer the FSER into evidence. Licensing Board Order (Regarding the Record for the Evidentiary Hearing) (April 3, 2008) at ¶ 6. The Staff has informed NEC's Counsel that it intends to file at least those portions of the FSER that are relevant to NEC's Contentions as NRC Staff Exhibit 01. The FSER is therefore referenced as such in this Statement and the testimony and reports of NEC's expert witnesses.

NEC's Contention 2 in this proceeding contests the sufficiency of this proposal. In its Order of September 22, 2006, the Board admitted NEC's Contention 2, stated as follows:

> **Entergy's License Renewal Application does not include an adequate plan to monitor and manage the effects of aging [due to metal fatigue] on key reactor components that are subject to an aging management review, pursuant to 10 C.F.R. § 54.21(a) and an evaluation of time limited aging analysis, pursuant to 10 C.F.R. § 54.21(c).**

In the Matter of Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc. (Vermont Yankee Nuclear Power Station), ASLBP 06-849-03-LR, 64 NRC 131, 183 (September 26, 2006). While it did not reach the merits of Contention 2 in its decision on admissibility, the Board did express some sympathy for NEC's observation in its Petition to Intervene that the LRA included only a "plan to develop a plan" to manage environmentally-assisted metal fatigue, noting that the LRA "appears to summarize options for future plans rather than demonstrating compliance." Id. at 184, 186.

After NEC filed its Contention 2 with the Board, Entergy submitted License Renewal Commitment 27, which reads in part:

> At least 2 years prior to entering the period of extended operation, for the locations identified in NUREG/CR-6260 for BWRs of the VY vintage, VY will refine our current fatigue analyses to include the effects of reactor water environment and verify that the cumulative usage factors (CUFs) are less than 1.

NRC Staff Exhibit 01 at A-8.

On August 20, 2007, the NRC Staff rejected Commitment 27 on the following grounds:

> It is the NRC position that in order to meet the requirements of 10 CFR § 54.21(c)(1), an applicant for license renewal must demonstrate *in the LRA*

> that the evaluation of the time-limited aging analyses (TLAA) has been completed. The NRC does not accept a commitment to complete the evaluation of TLAA prior to entering the period of extended operation.

NRC Summary of Telephone Conference Call Held on August 20, 2007, Between the U.S. Nuclear Regulatory Commission and Entergy Nuclear Operations, Inc., Concerning the Vermont Yankee Nuclear Power Station License Renewal Application (October 25, 2007), Exhibit NEC-JH_62 at Enclosure 2 (emphasis added). Entergy therefore agreed to amend its LRA to demonstrate that it had completed the refinement of its environmentally-assisted fatigue analysis to verify that CUFens for the NUREG/CR-6260 limiting locations are less than one. Id. Entergy then undertook the analyses that NEC's Contentions 2A and 2B address. Id.

As further explained in Part II(B) of this Statement, below, Entergy's CUFen reanalysis proceeded in two major steps. Entergy first performed a CUFen reanalysis addressing all components listed in its LRA Table 4.3-3, corresponding to the NUREG/CR-6260 limiting locations. When the NRC Staff rejected Entergy's initial approach, Entergy performed a so-called "confirmatory" analysis using a slightly different methodology, which addressed only the feedwater nozzles. NEC's Contention 2A addresses the "intial CUFen reanalysis." NEC's Contention 2B addresses the so-called "confirmatory" reanalysis of the feedwater nozzle.

In its Order of November 7, 2007, the Board admitted NEC's Contention 2A, stated as follows:

> **<u>[T]he analytical methods employed in Entergy's [environmentally corrected CUF, or] CUFen Reanalysis were flawed by numerous uncertainties, unjustified assumptions, and insufficient conservatism, and produced unrealistically optimistic results. Entergy has not, by this flawed reanalysis, demonstrated that the reactor components</u>**

assessed will not fail due to metal fatigue during the period of extended operation.

Board Memorandum and Order (Ruling on NEC Motions to File and Admit New Contention), November 7, 2007 at 3. By this same Order, the Board also stayed NEC's Contention 2, pending the resolution of Contention 2A. Id. at 12 ("[W]e conclude that NEC Contention 2A will be litigated now, and NEC Contention 2 will be held in abeyance.").

Finally, by its Order of April 24, 2008, the Board admitted NEC's Contention 2B, which the Board characterized as a subset of Contention 2A:

> NEC Contention 2A is still on the table and Entergy's ["confirmatory" analysis of the feedwater analysis"] was apparently intended to respond to certain aspects of that contention. NEC's current amendment, which we designate NEC Contention 2B, was apparently designed to prevent NEC from being foreclosed from challenging Entergy's Second CUFen Reanalysis, and is really just a subset of NEC Contention 2A.

Board Order (Granting Motion to Amend NEC Contention 2A), April 24, 2008 at 2.

B. Summary of NRC Staff Review of Entergy's CUFen Reanalyses

As explained in greater detail in Dr. Joram Hopenfeld's report, titled "Review of Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. ("Entergy") Analyses of the Effects of Reactor Water Environment on Fatigue Life of Risk-Significant Components During the Period of Extended Operation," Exhibit NEC-JH_03 at 4-7, Entergy's refinement of its CUFen analysis proceeded in several steps. Initially, Entergy performed an analysis involving, in part, the use of a simplified Green's function method to calculate stress loads during plant transient operations.[17] The NRC Staff, however, rejected Entergy's initial CUFen reanalysis because, as reported in the FSER, Entergy and the NRC Staff "were unable to resolve the issues raised [with respect

[17] The reports of this initial analysis that Entergy produced to NEC are submitted as Exhibits NEC-JH_04 – NEC-JH_18.

to Entergy's use of Green's functions to calculate stress loads]." FSER, NRC Staff Exhibit 01 at 4-40. The NRC Staff ultimately concluded that Entergy's initial reanalysis could not be the analysis of record due to insufficient conservatism stemming from the simplified Green's function method. Id. at 4-43 ("[T]he results of the Green's function application using the specific software could underestimate CUF, and therefore cannot be the analysis of record.").

The NRC Staff therefore requested that Entergy perform, and Entergy did perform, an additional so-called "confirmatory" CUFen analysis of only the feedwater nozzle, using the ASME Code Section III, Subsection NB-3200 methodology to calculate the stress intensities "without referencing Green's function."[18] FSER, NRC Staff Exhibit 01 at 4-41; *See also,* Exhibit NEC-JH_22 (Summary of Meeting Held on January 8, 2008, Between the U.S. Nuclear Regulatory Commission Staff and Entergy Nuclear Operations, Inc. Representatives to Discuss the Response to a Request for Additional Information Pertaining to the Vermont Yankee Nuclear Power Station License Renewal Application).

The NRC Staff ultimately accepted Entergy's so-called "confirmatory" analysis as the "analysis of record" for the feedwater nozzle. FSER, NRC Staff Exhibit 1 at 4-43. However, the NRC Staff apparently also determined that the "confirmatory" feedwater analysis cannot be considered bounding for other components, as it "concludes that similar analysis should be performed for the CS and RR outlet nozzles and that these analyses will be documented as the 'analysis of record' for these two nozzles." FSER, NRC Staff Exhibit 1 at 4-43. To this effect, "a license condition for performing the

[18] Entergy's reports of the "confirmatory" analysis are submitted as Exhibits NEC-JH_19 – NEC-JH_21.

ASME Code analyses for the CS and RR outlet nozzles will remain in effect until the applicant has completed and submitted those final analyses for NRC review and approval no later than two years prior to entering the [period of extended operations]." Id.

Finally, the NRC Staff has also apparently resurrected License Renewal Commitment 27. As stated above, the NRC Staff rejected this commitment in August, 2007 on grounds that "in order to meet the requirements of 10 CFR § 54.21(c)(1), an applicant for license renewal must demonstrate in the LRA that the evaluation of the time-limited aging analyses (TLAA) has been completed." Exhibit NEC-JH-62 at Enclosure 2. Now, however, it reverses its prior position to find that Entergy's commitment to complete the environmentally-assisted metal fatigue TLAA at least two years prior to entering the period of extended operation "will address environmentally assisted metal fatigue for the seven components which have not been addressed." Id.

C. Statement of Position and Roadmap to NEC's Evidence

NEC's position is that the CUFens calculated by both Entergy's initial and "confirmatory" CUFen analyses are unreliable. Acceptance of Entergy's results will lead to an unjustified reduction in the scope of fatigue monitoring at VYNPS that will jeopardize public health and safety. NEC specifically contends the following:

- Entergy used a flawed methodology in its initial CUFen reanalysis, resulting in the understatement of CUFen values. This analysis does not provide reasonable assurance that the components assessed, corresponding to the NUREG/CR-6260 limiting locations, will meet ASME criteria for safe operation, CUF less than one, throughout the period of extended operation.

- Entergy also used a flawed methodology in its so-called "confirmatory" reanalysis of the feedwater nozzle. This analysis therefore also fails to provide reasonable assurance that the components assessed, corresponding to the NUREG/CR-6260 limiting locations, will meet ASME criteria for safe operation, CUF less than one, throughout the period of extended operation.

- Entergy has not produced all information necessary to validate its CUFen reanalysis methodology. Entergy therefore has not satisfied its burden to prove by a preponderance of evidence that its CUFen reanalyses satisfy the reasonable assurance standard.

- Entergy's so-called "confirmatory" reanalysis of the feedwater nozzle does not bound the analysis for other components. For this reason, even if the confirmatory reanalysis was based on a valid methodology, Entergy's environmentally-assisted metal fatigue TLAA would still be incomplete and therefore insufficient to satisfy the "reasonable assurance" standard at this time.

- Entergy cannot resolve NEC's Contentions 2A and 2B or satisfy requirements of 10 CFR §§ 54.21(c) and 54.29 by committing, per License Renewal Commitment 27, to complete the TLAA for environmentally-assisted metal fatigue in the future, after its license renewal application is granted.

The following further discusses each of the above-stated aspects of NEC's position and provides a general roadmap to NEC's evidence with respect to each aspect of its position.

1. <u>Entergy Used a Flawed Methodology in Both its Initial and Confirmatory CUFen Reanalyses. Neither Analysis Satisfies the Reasonable Assurance Standard.</u>

Dr. Joram Hopenfeld notes several significant flaws in both Entergy's initial and so-called "confirmatory" analyses. This discussion is contained in both Dr. Hopenfeld's direct testimony, Exhibit NEC-JH_01 at 5-6, and his report, Exhibit NEC-JH_03 at 8-18, and references Entergy's reports of its analyses, Exhibits NEC-JH-04 – NEC-JH_21, as well as additional documents submitted as Exhibits NEC-JH_25, NEC-JH_26, NEC-JH_27, NEC-JH_ 28, NEC-JH_29, NEC-JH_30, NEC-JH_32, NEC-JH_33, and NEC-JH_35.

The flaws Dr. Hopenfeld has identified are generally as follows:

- Entergy's Fen parameters are based on outdated statistical equations stated in NUREG/CR-6583 and NUREG/CR-5704; current, more applicable and broader data, published in NUREG/CR-6090, is available and should be used. Exhibits NEC-JH_01 at 5; NEC-JH_03 at 10-12.

- Entergy used inappropriate heat transfer equations to calculate the thermal stress for each transient. Exhibits NEC-JH_01 at 5; NEC-JH_03 at 12-15.

- Entergy has not provided proof that the base metal of the feedwater nozzles is not cracked -- widespread cracks in other plants require Entergy to assume that such cracks exist in the absence of proof to the contrary. Exhibits NEC-JH_01 at 5; NEC-JH_03 at 15-16.

- Entergy's apparent assumption that the number of plant transients will be linear with time is not sufficiently conservative. Exhibits NEC-JH_01 at 5; NEC-JH_03 at 16.

- Entergy's calculation of Fen does not appropriately account for oxygen concentrations and resulting changes in water chemistry. Exhibits NEC-JH_01 at 5; NEC-JH_03 at 16-17.

Dr. Hopenfeld has also observed that the initial CUFen analysis included one additional flaw that was corrected in the "confirmatory" analysis: in its initial reanalysis, Entergy used a simplified Green's function methodology, which resulted in the underestimation of CUF values by approximately 40%. Exhibits NEC-JH_01 at 5-6; NEC-JH_03 at 6-7, 17-18.

As discussed in Part II(B) of this Statement, the NRC Staff rejected Entergy's initial CUFen reanalysis because of Entergy's use of a simplified Green's function methodology to calculate CUF values. Indeed, the NRC Staff is now revisiting the sufficiency of environmentally-assisted fatigue analyses based on the simplified Green's function method, which the NRC had previously accepted in support of license renewal for plants other than VYNPS. On April 18, 2008, the NRC Staff issued a Regulatory Issue Summary ("RIS"), requesting that "license renewal applicants that have used this simplified Green's function methodology perform confirmatory analyses to demonstrate that the simplified Green's function analyses provide acceptable results." Exhibit NEC-JH-23 at 2. This RIS also states: "For plants with renewed licenses, the staff is considering additional regulatory actions if the simplified Green's function methodology was used." Id. On April 3, 2008, the NRC Staff issued a Notification of Information in Docket No. 50-219-LR (License Renewal for Oyster Creek Nuclear Generating Station), stating that it will require "confirmatory" fatigue analyses due to Oyster Creek's reliance on the simplified Green's function method. Exhibit NEC-JH_24.

2. Entergy has not satisfied its burden to prove by a preponderance of evidence that its CUFen reanalyses satisfy the reasonable assurance standard.

Even if the Board does not agree that Entergy's CUFen Reanalysis is flawed for the reasons summarized in Part II(C)(1) of this Statement, it should decide Contentions 2A and 2B in NEC's favor because Entergy has not provided all of the information necessary to validate either of its analyses, and therefore fails to satisfy its burden of proof. Discussion of this issue is contained in the direct testimony of Dr. Joram Hopenfeld, Exhibit NEC-JH_01 at 5, Dr. Hopenfeld's report, Exhibit NEC-JH_03 at 8-9, 13-14, with reference to additional documents submitted as Exhibits NEC-JH_25, NEC-JH_10.

Generally, Dr. Hopenfeld explains that Entergy has not produced layout drawings of the VYNPS piping from which it would be possible to obtain information necessary to validate the assumption of uniform heat transfer distribution. Exhibit NEC-JH_03 at 3. Entergy has not fully explained the methods or models it used to determined temperatures and velocities during transients. Id. Finally, Entergy has not provided an error analysis to show the admissible range for each variable in its CUFen analyses. Id. at 18. Without an error band, Entergy's results have little significance and impart little confidence that fatigue failure will not occur.

3. Entergy's so-called "confirmatory" reanalysis of the feedwater nozzle is not bounding.

Entergy's so-called "confirmatory" analysis of the feedwater nozzle does not bound the analysis for other components. Even if the Board does not agree that the confirmatory reanalysis methodology is invalid, it should decide Contentions 2A and 2B in NEC's favor because Entergy's TLAA is incomplete, and therefore cannot satisfy the reasonable assurance standard with respect to all NUREG/CR-6260 limiting locations. Discussion of this issue is contained in the direct testimony of Dr. Joram Hopenfeld, Exhibit NEC-JH_01 at 6-7, and Dr. Hopenfeld's report, Exhibit NEC-JH_03 at 18-19.

As discussed in Part II(B) of the Statement, the NRC Staff apparently concurs with NEC that Entergy's "confirmatory" analysis of the feedwater nozzle should not be considered bounding, as it "concludes that similar analysis should be performed for the CS and RR outlet nozzles and that these analyses will be documented as the 'analysis of record' for these two nozzles." FSER, NRC Staff Exhibit 1 at 4-43.

4. Entergy's License Renewal Commitment 27 Does Not Resolve NEC's Contentions 2A and 2B.

Neither Entergy's License Renewal Commitment 27, nor a license condition requiring performance of the ASME Code analyses for the CS and RR outlet nozzles no later than two years before the period of extended operations resolves NEC's Contentions 2A and 2B. This commitment and condition are insufficient to satisfy Entergy's obligations under 10 C.F.R. §§ 54.21(c) and 54.29 and their acceptance by the Board would defeat NEC's due process rights in this proceeding and deny public review of Entergy's TLAA. As the NRC Staff stated with respect to this very issue in August, 2007: "to meet the requirements of 10 C.F.R. § 54.21(c)(1), an applicant for license renewal must demonstrate in the LRA that the evaluation of the time-limited aging analyses (TLAA) has been completed." Exhibit NEC-JH_62 at Enclosure 2. Likewise, as the Board observed in its Order admitting NEC's Contention 2, Entergy cannot rely on "future plans;" the LRA must "demonstrate compliance." *In the Matter of Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc. (Vermont Yankee Nuclear Power Station*, 64 NRC at 186.

*   *   *

The Board should require Entergy to develop a valid methodology for calculating CUFen; expand its fatigue analysis to components in addition to the NUREG/CR-6260 limiting locations if a valid CUFen analysis indicates that CUFen for any NUREG/CR-6260 location will exceed unity; and formulate a plan to inspect and maintain all components susceptible to environmentally-assisted metal fatigue. The inspection and maintenance plan should be based on correct CUFen values.

III. NEC CONTENTION 3 (Steam Dryer)

NEC's Contention 3 addresses whether Entergy has proposed a program to manage aging of the VYNPS steam dryer that will provide reasonable assurance that the steam dryer will be maintained in accordance with the CLB during the period of extended operation. In its September 11, 2007 decision of Entergy's Motion for Summary Disposition of NEC's Contention 3, the Board narrowed the scope of Contention 3 to the following three issues: (1) the sufficiency of Entergy's assessment program for steam dryer monitoring data; (2) the qualifications of the personnel who will evaluate this information; and (3) whether the aging management plan should include stress analysis for comparison to fatigue limits as a component of the plan. Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 3), September 11, 2007 at 12.

NEC's direct testimony and exhibits address the third of these issues. This discussion is contained in the direct testimony of Dr. Joram Hopenfeld, Exhibit NEC-JH_01 at 7-9, and Dr. Hopenfeld's Report, titled "Assessment of Proposed Program to Manage Aging of the Vermont Yankee Steam Dryer Due to Flow-Induced Vibrations," Exhibit NEC-JH_54, and references the additional documents filed as Exhibits NEC-JH_55 – NEC-JH_61.

In support of its Motion for Summary Disposition of NEC's Contention 3, Entergy filed a Declaration of John R. Hoffman, in which Mr. Hoffman represented that Entergy's aging management program for the steam dryer during the period of extended operations will consist exclusively of periodic visual inspection and monitoring of plant parameters as described in General Electric Service Information Letter 644 (GE-SIL-644), and will not involve the use of any analytical tool to estimate stress loads on the steam dryer. Entergy also represented that it will not rely on the finite element modeling conducted prior to implementation of the extended power uprate (EPU) in 2006 for knowledge of steam dryer stress loads. The Board accepted this representation. Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 3), September 11, 2007 at 10 ("Entergy's expert confirms that this program does not require the use of the CFD and ACM computer codes or the finite element modeling conducted during the EPU.").

Entergy described its proposed program as follows:

> The aging management program for the VY steam dryer during the twenty-year license renewal period will consist of well-defined monitoring and inspection activities that are defined in GE SIL-644 guidelines and are identical to those being conducted during the current post-EPU phase. Steam dryer integrity will be monitored continuously via operator monitoring of certain plant parameters. VY Off-normal Procedure ON-3178 alerts the operators that any of the following events could be indicative of reactor internals damage and/or loose parts generation: a) a sudden drop in main steam line flow > 5%; b) > 3 inch difference in reactor vessel water level instruments; c) sudden drop in steam dome pressure > 2 psig. In addition, periodic measurements of moisture carryover will be evaluated in accordance with the requirements of GE-SIL-644. This monitoring program will continue for the entire license renewal period. The inspection activities will include visual inspections of the steam dryer every two refueling outages consistent with GE and BWR Vessel Internals Program (VIP) requirements. The inspections will focus on areas that have been repaired, those where flaws exist, and areas that

> have been susceptible to cracking based on reactor operating experience throughout the industry.
>
> The aging management plan for the license renewal period, consisting of the monitoring and inspection activities described above, does not depend on, or use, the CFD and ACM computer codes or the [finite element modeling] conducted using those codes.

Declaration of John R. Hoffman in Support of Entergy's Motion for Summary Disposition of NEC Contention 3, Exhibit NEC-JH_61 at ¶¶ 23-24; see also, LRA § 3.1.2.2.11.

It is Dr. Hopenfeld's professional opinion that Entergy's proposed program of periodic visual inspection and parameter monitoring, uninformed by knowledge of stress loads on the dryer, will not provide reasonable assurance that the structural integrity of the steam dryer will be maintained so that generation of loose parts during normal operation, transients and accident events is prevented. Exhibits NEC-JH_01 at 8-9, NEC-JH_61 at 1, 5-6. Dr. Hopenfeld recommends that the aging management program should also 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. Exhibits NEC-JH_01 at 9, NEC-JH_61 at 5-6.

Dr. Hopenfeld explains that parameter monitoring generally will only indicate that a failure has occurred, rather than preventing dryer damage, and notes the GE-SIL-644[19] advises that "monitoring steam moisture content and other reactor parameters does not consistently predict imminent dryer failure not will it preclude the generation of loose parts." NEC-JH_61 at 5-6. He advises that Entergy's proposed program is unlikely to detect cracking of the steam dryer during the interval between inspections that could quickly propagate and lead to the hazardous generation of loose parts. Exhibit NEC-

[19] GE-SIL_644 is submitted as Exhibit NEC-JH_55.

JH_01 at 9, NEC-JH_61 at 2-3, 4. He notes that any repairs to the dryer must be informed by knowledge of dryer loads. NEC-JH_61 at 5.

Finally, Dr. Hopenfeld explains that the VYNPS steam dryer must be carefully managed because the twenty percent increase in operating power implemented in 2006 increased steam velocity, and thereby increased the potential for creation of fluctuating pressure loading that could damage the steam dryer. Exhibit NEC-JH_01 at 9, NEC-JH_61 at 1-2. With respect to this issue, Dr. Hopenfeld discusses steam dryer failures following operating power uprates at two other plants. Exhibits NEC-JH_61 at 2.

IV. NEC CONTENTION 4
(Flow-Accelerated Corrosion)

The Board defined the scope of NEC's Contention 4 as follows:

> NEC Contention 4 alleges 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), ie, "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."

Memorandum and Order (Ruling on Standing, Contentions, Hearing Procedures, State Statutory Claim, and Contention Adoption), LBP-06-20, 64 NRC 131, 192 (2006).

Entergy's LRA states that its FAC management program during the period of extended operation will be comparable to the program described in NUREG-1801, Vol. 2, Rev. 1, Section XI.M17. LRA at B-47. NUREG 1801 XI.Ml7 states that the FAC program:

> Relies on implementation of the Electric Power Research Institute (EPRI) guidelines in the Nuclear Safety Analysis Center (NSAC)-202L-R2 for an effective flow-accelerated corrosion (FAC) program. The program includes performing (a) an analysis to determine critical locations, (b) limited baseline

inspections to determine the extent of thinning at these locations, and (c) follow-up inspections to confirm the predictions, or repairing or replacing components as necessary.

In its Motion for Summary Disposition of NEC's Contention 4, Entergy provided additional information regarding its proposed program. Entergy represented that its FAC management program during the period of extended operation will be identical to the FAC program now in effect at VYNPS under the current operating license. *See,* Joint Declaration of Jeffrey S. Horowitz and James C. Fitzpatrick In Support of Entergy's Motion for Summary Disposition of NEC Contention 4 (May 31, 2007) at ¶ 25. Entergy further represented that this program will serve as an adequate aging management plan because it appropriately implements industry guidance. Id. at ¶ 32. Entergy also represented that it will use the CHECWORKS model as a tool to define the scope of FAC inspection. Id. at ¶ 26.

A. Statement of Position and Roadmap to NEC Evidence

NEC contends that Entergy's proposed FAC management program will not provide adequate assurance that, consistent with the CLB, minimum wall thickness of plant equipment vulnerable to FAC will not be reduced by FAC to below ASME code limits during the twenty-year period of extended operations for the following reasons:

- Entergy cannot successfully use the CHECWORKS model as part of its FAC program during the renewed license term because it will not be possible to properly calibrate CHECWORKS to EPU operating conditions before expiration of the current VYNPS license; and
- The current VYNPS FAC program does not appropriately implement industry guidance, and will not constitute an adequate aging management plan with respect to FAC.

The following further discusses each of the above-stated aspects of NEC's position and provides a general roadmap to NEC's evidence with respect to each aspect of its position.

2. <u>The current VYNPS FAC program does not appropriately implement industry guidance, and will not constitute an adequate aging management plan with respect to FAC</u>.

NEC's discussion of this issue is contained in Dr. Joram Hopenfeld's report, titled "Review of Entergy License Renewal Application for VYNPS: Program for Management of FAC," Exhibit NEC-JH_36; the testimony of Mr. Ulrich Witte, Exhibit NEC-UW_01; Mr. Ulrich 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.

Dr. Hopenfeld contests engineering assumptions underlying Entergy's current FAC program. Exhibit NEC-JH_36 at 11. Mr. Witte, based on his review of records Entergy has produced to NEC in this proceeding, including Entergy's own assessments, audits, condition and cornerstone reports, and focused self assessments, concludes that the VYNPS FAC program was in noncompliance with both the plant's current licensing basis and EPRI guidance from about 1999 through February, 2008, and that a proper pre-EPU baseline may not have been established.

Mr. Witte's findings are detailed in his report, NEC-UW_03. They include the following:

- Contrary to EPRI recommendations, from 1999-the present, Entergy apparently failed to fully update the CHECWORKS model in use at VYNPS with plant inspection data or information concerning plant modifications, including those related to

EPU. This lengthy lapse may have significantly weakened the trending and predictive capability of the software, both during the lapse period and presently. Exhibits NEC-UW_03 at 2, 6-7, 16 ; NEC-UW_9 at 2; NEC-UW_14; NEC-UW_08 at 1, 2, 4, 6; NEC-UW_20 at 2.

■ 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. Exhibits NEC-UW_03 at 16-17; NEC-UW_05 at NEC017893.

■ 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. Exhibits NEC-UW_03 at 2, 18; NEC-UW_9 at NEC038514, NEC038419, NEC038422; NEC-UW_07.

■ 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. Exhibits NEC-UW_03 at 20.

■ Entergy's VYNPS FAC inspections typically encompass significantly fewer inspection points that the average for the domestic industry. Exhibits NEC-UW_03 at 8; Exhibit NEC-UW_11 at 43..

1. <u>It is not possible to recalibrate the CHECWORKS model to EPU operating conditions before expiration of the current VYNPS operating license.</u>

NEC's evidence concerning recalibration of the CHECWORKS model is contained in the direct testimony of Joram Hopenfeld, 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," 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.

Mr. Witte cites industry guidance supporting 5-10 years of data trending, and notes that trending to the high end of this range is appropriate where variables affecting wear rate have significantly changed. Exhibit NEC-UW_03 at 21; Exhibit NEC-UW_13 at 38. Mr Witte is skeptical that CHECWORKS incorporates FAC data from plants that can be reasonably compared to VYNPS. He notes that only six operating plants have increased operating power by more than fifteen percent (15%), and that half of these have experienced problems with FAC. Exhibit NEC-UW_03 at 21-22; NEC-UW_18; NEC-UW_05. Finally, as stated above, Mr. Witte explains that flaws in Entergy's implementation of its FAC program, particularly its failure to consistently update the CHECWORKS model, have reduced the model's predictive capability. Mr. Witte states that "[g]iven the deficiencies in the current VYNPS FAC program discussed in this statement, trending under the program is of marginal value." Exhibit NEC-UW_03 at 23.

Mr. Witte further states that "benchmarking [of the CHECWORKS MODEL] can only be accomplished after the current program deficiencies are corrected and a proper baseline established." Exhibit NEC-UW_03 at 23.

Dr. Hopenfeld explains the following regarding CHECWORKS and the FAC phenomenon:

- CHECWORKS is an empirical model that must be calibrated with plant-specific data. If relevant plant parameters change, the model must be recalibrated based on sufficient inspection data to reestablish reliable FAC trends under the new operating conditions. Exhibit NEC-JH_01 at 11; Exhibit NEC-JH_36 at 6-8.

- Calibration of CHECWORKS is difficult because FAC is highly localized, may not be linear with time, and results from the interaction of many complex physical processes. Exhibit NEC-JH_01 at 11; Exhibit NEC-JH_36 at 2-8.

- The twenty percent increase in the Vermont Yankee plant's operating power implemented in 2006 changed relevant parameters including flow velocity. This increase in flow velocity will likely result in new locations of high corrosion that CHECWORKS as-calibrated to pre-uprate conditions will be unable to predict. Exhibit NEC-JH_01 at 12.

- Entergy therefore cannot successfully use CHECWORKS at Vermont Yankee until the model is recalibrated to the current operating conditions, which will take 12-15 years. Exhibit NEC-JH_01 at 12; Exhibit NEC-JH_36 at 14-16.

- Reliance on CHECWORKS before full recalibration could result in an improper scope of FAC inspection, and the failure to inspect and identify hazardous FAC of plant equipment. Exhibit NEC-JH_01 at 11; Exhibit NEC-JH_36 at 6-8.

Dr. Hopenfeld further explains his view that shortcomings in Entergy's current FAC program may lengthen the time needed to calibrate CHECWORKS. First, CHECWORKS will provide accurate predictions concerning only those components that were inspected during the calibration period; the number of inspection points in Entergy's program may be too low to collect enough data. Exhibit NEC-JH_01 at 12. Second, Dr. Hopenfeld questions the basis for CHECWORKS' guidelines for grid size selection, and believes that Entergy will not collect sufficient data to calibrate the model if it follows these recommendations. Id.

Finally, Dr. Hopenfeld does not believe that use of CHECWORKS or its predecessors, CHEC and CHECMATE ("the CCC Codes"), has resulted in a reduced incidence of FAC failures. He observes that NUREG/CR-6936 reports a ten percent reduction in through-wall pipe failures from FAC in BWRs and PWRs since CHEC was introduced in 1987, but believes this reduction is most likely attributable to increased awareness of FAC by all plants following the catastrophic Surry plant accident, not to the use of the CCC codes. Id. at 13. Dr. Hopenfeld's report lists multiple examples of the failure of the CCC codes to predict precursors to FAC incidents. Exhibit NEC-JH_9-11.

Dr. Hausler's report explains why Entergy cannot rely on FAC inspection grids established prior to the power uprate. Dr. Hausler provides an overview of the parameter field which must be considered and controlled in 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 FAC. Exhibit NEC-RH_03 at 1-12. He further explains that the location of FAC will change as the flow rate changes, and 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. Id. at 7.

Dr. Hausler also offers his professional opinion that 12-15 years is a reasonable estimate of the time necessary to recalibrate an empirical model such as the CHECWORKS model. Id at Appendix A. In support of this conclusion, he submits a statistical evaluation. Id.

* * *

The Board should require Entergy to replace all FAC susceptible piping and components with FAC resistant piping and components prior to extended license operation, in order to restore reasonable assurance of public health and safety. The Board should also require Entergy to formulate a new plan to manage FAC during the period of extended operation that does not rely on CHECWORKS predictions. The new plan must specify a scientifically-based component sampling and inspection grid size determined by turbulence intensity.

V. CONCLUSIONS

Unless the important issues addressed by NEC's Contentions 2A, 2B, 3 and 4 are resolved, the operation of the VYNPS for an additional twenty years will threaten public health and safety.

April 28, 2008 New England Coalition, Inc.

by: Karen Tyler

Andrew Raubvogel
Karen Tyler
SHEMS DUNKIEL KASSEL & SAUNDERS PLLC
For the firm

Attorneys for NEC

REDACTED

NEC-JH_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

June 20, 2006

PRE-FILED DIRECT TESTIMONY OF Dr. JORAM HOPENFELD REGARDING NEC CONTENTIONS 2A, 2B, 3 AND 4

Q1. Please state your name and address.

A1. My name is Dr. Joram Hopenfeld.

Q2. What is your educational and professional background?

A2. I received the following degrees in mechanical engineering from the University of California at Los Angeles: BS (1960), MS (1962), and Ph.D (1967).

I have 45 years of experience in industry and government, including eighteen years with the U.S. Nuclear Regulatory Commission ("NRC"), primarily in the areas of thermal hydraulics, materials, corrosion, radioactivity transport, instrumentation, PWR steam generator testing, and accident analysis. I have managed major international programs on steam generator performance during accidents involving various thermal transients. Following a decade of studies, debates and Advisory Committee on Reactor Safety hearings, the NRC adopted my position regarding the safety implication of steam generator tube degeneration. In 2001, the NRC launched a five-year major program on the effects of steam generator tube aging on core melt.

I have consulted with citizens groups and their attorneys regarding steam generators, thermal hydraulics, corrosion and metal fatigue in connection with license renewals and power upgrades.

My employment history is as follows. From 1962-1971, I worked for Atomics International. In this position, I was involved in corrosion testing of materials for the design and operation of liquid metal cooled nuclear reactors, modeling sodium fires, and modeling destruction of SNAP fuel rods on reentry into the earth atmosphere. From 1971-1973, I was on the Staff of the Atomic Energy Commission, where I participated in the resolution of design issues as related to material corrosion, material coolant interaction, and thermal hydraulics of nuclear reactors. From 1973-1978, I was Project Manager for the safety evaluation and testing of steam generators for liquid cooled nuclear reactors with the U.S. Department of Energy/ERDA. In this position, I managed the development of thermal – hydraulic computer codes such as COBRA, and the development of acoustic leak detection systems for sodium/water nuclear reactors. I was also responsible for testing material compatibility and cavitation damage in sodium. From 1978-1982, I was Project Manager for the development of materials and instrumentation for high-temperature steam generators for fossil-fuel plants with the U.S. Department of Energy. In this position, I was responsible for the resolution of issues relating to corrosion/erosion and NOx/Sox emissions. From 1982-2001, I worked on the NRC Staff as Program manager for the resolution of various thermal hydraulics, material corrosion, and safety issues.

I have also published several peer-reviewed papers on thermal hydraulics, corrosion/erosion, steam generator dose releases during accidents, steam explosions, sensors, and ECM machining.

Further details of my experience are stated on my Curriculum Vitae filed with this testimony, Exhibit NEC-JH_02.

NEC CONTENTIONS 2A AND 2B
(Environmentally-assisted metal fatigue analyses)

Q3. What is your understanding of the issues presented by New England Coalition's (NEC's) Contentions 2A and 2B in this proceeding?

A3. NEC's Contentions 2A and 2B address whether certain analyses the license renewal Applicant has performed are sufficient to demonstrate that Vermont Yankee Nuclear Power Station components that are vulnerable to environmentally-assisted metal fatigue will meet the ASME Code acceptance criteria, which is cumulative usage factor less than one, throughout the period of extended plant operations.

I refer to these analyses as the "initial CUFen analysis" and the "confirmatory CUFen analysis." The initial CUFen analysis assessed the impact of environmentally-assisted metal fatigue on nine components listed in Table 4.3-3 of the License Renewal Application, and selected to correspond to the limiting locations identified in NUREG/CR-6260. The "confirmatory" CUFen analysis assessed impacts on only the feedwater nozzle by a different methodology.

Q4. Did you prepare a report of your evaluation of the applicant's initial and confirmatory CUFen analyses?

A4. Yes I did. My report is filed with this testimony as Exhibit NEC-JH_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 Contentions 2A and 2B.

Q5. What materials did you review in preparation of your testimony and report?

A5. The most relevant materials I reviewed include the following: the Applicant's License Renewal Application, and amendments to that Application; the NRC Staff's Final Safety Evaluation Report; eighteen reports of the Applicant's CUFen analyses, filed with this testimony as Exhibits NEC-JH_04 – NEC-JH_21; the additional documents filed with this testimony as Exhibits NEC-JH_22 – NEC_JH-35 and NEC-JH_63; the documents I have identified as references to my report; and the additional documents to which I refer in the body of my report, for example, Section III of the ASME Code. These are the type of materials and formulae normally relied on by persons in my profession for such analyses.

Q6. Did you have sufficient information to formulate your assessment of the Applicant's analyses?

A6. Yes, I had sufficient information to formulate the assessment stated in my report. The Applicant did not, however, produce complete information to NEC regarding its methodology for either the initial or "confirmatory" CUFen analysis. As I have explained in my report, the information the Applicant produced is insufficient to prove the validity of either analysis.

Q7. Please briefly summarize your assessment of the Applicant's analyses.

A7. In a nutshell, the Applicant's analyses do not provide reasonable assurance that the predicted fatigue life of risk-significant components at Vermont Yankee Nuclear Power Station will meet ASME criteria for safe operation for the proposed extended period of operation. Neither the initial nor the "confirmatory" analysis is adequate to establish with reasonable assurance that the environmentally corrected Cumulative Usage Factor (CUFen) for the components listed in License Renewal Application Table 4.3-3 or NUREG/CR-6260 limiting locations will remain less than one. It is my opinion that acceptance of the Applicant's results will lead to an unjustified reduction in the scope of fatigue monitoring at the Vermont Yankee Nuclear Power Station.

Q8. Please briefly summarize the bases for your assessment.

A8. The bases for my assessment are explained in detail in my report. In short, there are significant flaws in both the Applicant's initial and so-called "confirmatory" analyses.

First, the Applicant has not provided all of the information necessary to establish the validity of either of its analyses. I detail the specific items of missing information in my report.

Second, the assumptions underlying the Applicant's analyses are not sufficiently conservative, and are faulty and inappropriate for the reasons stated in my attached report. Faulty assumptions result in the overestimation of fatigue life for the reasons stated in my report. Generally, in both the initial and "confirmatory" analyses: (1) the Applicant's Fen parameters are based on outdated statistical equations and inappropriate application of laboratory data to reactor condition -- current, more applicable and broader data is available and should be used; (2) the Applicant used inappropriate heat transfer equations to calculate the thermal stress for each transient; (3) the Applicant has not provided proof that the base metal of the feedwater nozzles is not cracked -- widespread cracks that have occurred in other plants require the Applicant to assume that such cracks exist in the absence of proof to the contrary; (4) the Applicant's apparent assumption regarding the number of transients is not sufficiently conservative; and (5) the

Applicant's calculation of Fen does not appropriately account for oxygen concentrations. The initial CUFen analysis included one additional flaw that was corrected in the "confirmatory" analysis: the Applicant's use of an oversimplified Green's function methodology resulted in the underestimation of CUF values in the initial CUFen analysis by approximately 40%.

Third, the Applicant should have validated its analytical technique with an error analysis showing the admissible range of each variable. The Applicant did not do so.

Fourth, the so-called "confirmatory" analysis of the feed-water nozzle repeats all of the CUF and Fen errors of the initial analysis, with the exception of the error in the calculation of CUF values resulting from use of the simplified Green's functions.

Fifth, the so-called "confirmatory" analysis was performed only for the feedwater nozzle. It does not bound the analysis for other components that are vulnerable to environmentally-assisted metal fatigue.

In sum, the CUFens calculated by Entergy, with and without the simplified Green's Function method, contain error and are unreliable. An alternative to these calculations is to use conservative CUF values as were originally provided in the LRA and multiply them by bounding Fen values given in NUREG/CR-6909. Such results are stated in my report.

Q9. Do you think the Applicant's CUFen analysis is complete?

A9. No, I do not. As I have already explained, I do not think the Applicant used a valid methodology in either its initial or "confirmatory" analysis, and therefore cannot consider the analysis complete. Even if I could agree that the Applicant used a valid methodology in its so-called "confirmatory" analysis of the feedwater nozzle, I still could not consider the CUFen analysis complete, because the analysis of the feedwater nozzle is not bounding for other components. To "complete" its analysis using the so-called confirmatory methodology, assuming it were valid, the Applicant would need to calculate CUFen by this method for the remainder of the components listed in License Renewal Application Table 4.3-3, which were selected to correspond to the limiting locations identified in NUREG/CR-6260.

Q10. What do you believe the Atomic Safety and Licensing Board should require the Applicant to do to provide reasonable assurance that components vulnerable to environmentally-assisted metal fatigue will meet ASME Code acceptance criteria during the period of extended operation?

A10. The Board should require the Applicant to develop a valid methodology for calculating CUFen; expand its fatigue analysis to components in addition to the NUREG/CR-6260 locations if a valid CUFen analysis indicates that CUFen for any NUREG/CR-6260 limiting location will exceed unity; and formulate a plan to properly inspect and maintain all components susceptible to environmentally-assisted fatigue. The plan must be based on using the appropriate CUFen values. Anything short of this will be inadequate to protect public health and safety.

NEC CONTENTION 3

(steam dryer aging management program)

Q11. What is your understanding of the issues presented by New England Coalition's (NEC's) Contention 3 in this proceeding?

A11. NEC's Contention 3 is about whether the Applicant has proposed an aging management program adequate to ensure maintenance of the Vermont Yankee Nuclear Power Station steam dryer in accordance with the current licensing basis, or CLB, for the period of extended operation. Contention 3 specifically addresses whether the Applicant's steam dryer aging management program must include some means of estimating and predicting stress loads on the steam dryer for comparison to ASME fatigue limits.

Q12. Did you prepare a report of your evaluation of the Applicant's steam dryer aging management plan?

A12. Yes, I did. This report is filed with this testimony as Exhibit NEC-JH_54. 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 3.

Q13. What materials did you review in preparation of your testimony and report?

A13. The most relevant materials I reviewed include the Applicant's License Renewal Application and amendments to that Application; the NRC Staff's Final Safety Evaluation Report; the documents filed with this testimony as Exhibits NEC-JH_55 – NEC-JH_61; and the additional documents referenced in the body of my report.

Q14. What must the Applicant's steam dryer aging management plan accomplish?

A14. The Applicant's steam dryer aging management plan must ensure that the structural integrity of the steam dryer is maintained so that generation of loose parts during normal operation, transients and accident events is prevented. A public safety hazard would result if parts of the steam dryer broke loose and were transported by flow or gravity to other areas of the reactor.

Q14. Please briefly summarize your assessment of Entergy's steam dryer aging management plan.

A14. I do not believe that the Applicant's proposed steam dryer aging management plan provides reasonable assurance that the steam dryer will be maintained consistent with CLB during the period of extended operations. I further believe that operation of the steam dryer as currently intended by the Applicant is in violation of GDC 1 and Draft GDC-40 and-42 insofar as they require that protection must be provided against the dynamic effects of loss of coolant accidents.

Q16. Please briefly summarize the bases for this assessment.

A16. I explain my assessment of the proposed steam dryer aging management program in my report. Generally, the Applicant has represented that its program will consist solely of periodic visual inspection and monitoring of plant parameters, uninformed by knowledge of stress loads on the dryer. This program is inadequate to detect cracking of the steam dryer during the interval between inspections. Such cracks could quickly propagate and lead to the hazardous generation of loose parts.

The aging management program should also 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.

The steam dryer aging management program is especially important at the Vermont Yankee plant because the twenty percent increase in operating power implemented in 2006 increased steam velocity, and thereby increased the potential for creation of fluctuating pressure loading that could damage the steam dryer.

NEC CONTENTION 4

(flow-accelerated corrosion management plan)

Q17. What is your understanding of the issues presented by New England Coalition's (NEC's) Contention 4 in this proceeding?

A17. NEC's Contention 4 concerns whether the Applicant's proposed program to monitor and manage aging of plant equipment subject to flow-accelerated corrosion (FAC) provides reasonable assurance that minimum wall thickness of this plant equipment will not be reduced by FAC to below ASME code limits during the period of extended operation. FAC is a physical phenomenon in which metal dissolution is accelerated by fluid flow.

Q18. Did you prepare a report of your evaluation of the Applicant's proposed FAC management plan?

A18. Yes, I did. This report is filed with this testimony as Exhibit NEC-JH_36. 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.

Q19. What materials did you review in preparation of your testimony and report?

A19. The most relevant materials I reviewed include the following: the Applicant's License Renewal Application, and amendments to that Application; the NRC Staff's Final Safety Evaluation Report; the documents filed with this testimony as Exhibits NEC-JH_37 – NEC_JH-53; the documents I have identified as references to my report; and the additional documents to which I refer in the body of my report.

Q20. Please briefly summarize your assessment of the Applicant's FAC management program.

A21. The Applicant's proposed FAC management program does not provide reasonable assurance that equipment vulnerable to FAC will be maintained according to the CLB during the entire period of extended operation. The Applicant proposes to use the CHECWORKS model for purposes of defining the scope and frequency of FAC inspections. It is my opinion that the Applicant cannot successfully use the CHECWORKS model for this purpose during at least a portion of the period of extended operations because it will not be possible, before expiration of the Vermont Yankee plant's current operating license, to properly calibrate CHECWORKS to account for changes in plant parameters resulting from the twenty percent increase in Vermont Yankee's operating power implemented in 2006.

Q22. Please briefly summarize the bases for your assessment.

A22. My assessment is explained in detail in my report. In summary, the CHECWORKS model provides plant operators a framework to rank plant components in accordance with their susceptibility to FAC. It is an empirical model that must be calibrated with plant-specific data. If relevant plant parameters change, the model must be recalibrated based on inspection data from a large number of carefully selected potentially vulnerable components to reestablish reliable FAC trends under the new operating conditions.

Calibration of CHECWORKS is difficult because FAC is highly localized, may not be linear with time, and results from the interaction of many complex physical processes. One must know the exact spot on a given component where conditions are most favorable to FAC. The knowledge that one component is more susceptible to FAC than others is not sufficient. Two components of apparently the same materials subjected to almost the same velocities and water chemistry may exhibit different FAC damage. One component may be severely damaged from FAC while the other would exhibit little or no damage.

The twenty percent increase in the Vermont Yankee plant's operating power implemented in 2006 changed relevant parameters including flow velocity. It is my professional opinion that this increase in flow velocity will likely result in new locations of high corrosion that CHECWORKS as calibrated to pre-uprate conditions will be unable to predict. The applicant therefore cannot successfully use CHECWORKS at Vermont Yankee until the model is recalibrated to the current operating conditions. As explained in detail in my report, it is my professional opinion that it will take 12-15 years to accomplish this recalibration.

CHECWORKS predictions should not be used to inform the scope or frequency of FAC inspections until the model is fully recalibrated. Reliance on CHECWORKS before full recalibration could result in an improper scope of FAC inspection, and the failure to inspect and identify hazardous FAC of plant equipment.

Q23. Do you have any concerns about whether this Applicant can properly calibrate CHECWORKS, even in 10-15 years?

A23. Yes, I do. First, CHECWORKS will provide accurate predictions concerning only those components that were inspected during the calibration period; the code is restricted to the inspected components. The applicant has represented that it intends to increase the number of FAC inspections during the interval between implementation of the operating power uprate and the expiration of the current Vermont Yankee operating license. To my knowledge, however, it has not disclosed what this means in terms of the total percentage of component piping and surface area susceptible to FAC that will be covered during the three outages.

Second, as explained in my report, FAC is a highly localized phenomenon that results from local turbulence, which is directly controlled by local flow velocity. The FAC inspection grid size is therefore a critical issue. [redacted] I am not aware of any published report in the scientific literature that would support this recommendation. If the Applicant follows this recommendation, it is my opinion that it will not collect sufficient FAC data to calibrate CHECWORKS.

Q24. Do you think that industry FAC experience since the introduction of the CHEC family codes demonstrates that CHECWORKS and its predecessors (CHEC and CHECMATE) have been successful in preventing FAC failures?

A24. No. As explained in my report, NUREG/CR-6936 reports a ten percent reduction in through-wall pipe failures from FAC in BWRs and PWRs since CHEC was introduced in 1987. In my professional opinion, this reduction is most likely attributable to increased awareness of FAC by all plants following the catastrophic Surry accident, not to the use of the CCC codes. My report also lists multiple examples of the failure of the CCC codes to predict precursors to FAC incidents.

Q25. What do you think the Board should require the Applicant to do with respect to its proposed FAC management program?

A25. I recommend that the Board require the Applicant to replace all FAC susceptible piping and components with FAC-resistant piping and components prior to extended license operation, in order to restore reasonable assurance of public health and safety. I further recommend that the Board require the Applicant to formulate a new plan to manage FAC during the period of extended operation that does not rely on CHECWORKS predictions. The new plan must specify a scientifically-based component sampling and inspection grid size determined by turbulence intensity.

Q26. Does this conclude your testimony regarding NEC's Contentions 2A, 2B, 3, and 4 at this time?

A26. Yes it does.

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

Joram Hopenfeld

Joram Hopenfeld, PhD

At Rockville, Maryland, this 18th day of April, 2008 personally appeared Joram Hopenfeld, and having subscribed his name acknowledges his signature to be his free act and deed.

Before me:

04/18/08

Notary Public

My Commission Expires ______________________

THIERRY K. SOFON
Notary Public State of Maryland
My Commission Expires Sept. 15, 2009

Curriculum Vitae for Dr. Joram (Joe) Hopenfeld

A. Professional Expertise: **Nuclear Safety and Licensing** (design basis/severe accidents) **Thermal/Hydraulics, Materials/Environment Interaction** (corrosion, erosion, stress corrosion, fatigue) **Radioactivity Transport, Industrial Instrumentation and Environmental Monitoring.**

B. Current Position - CEO, Noverflo, Inc

C. Education - Engineering- University of California at Los Angeles: BS 1960, MS 1962, Ph.D 1967.

D. Summary of Work Experience

1. Nuclear Plant Related Experience

I have 45 years of experience in industry and government primarily in the areas of thermal hydraulics, materials, corrosion, radioactivity transport, instrumentation, PWR steam generator testing and accident analysis. I have managed major international programs on steam generator performance during accidents involving various thermal transients. Following a decade of studies and debates and Advisory Committee on Reactor Safety hearings, the Nuclear Regulatory Commission, ("NRC") adopted my position regarding the safety implication of steam generator tube degradation. In 2001 the NRC launched a five-year major program on the effects of steam generator tube aging on core melt. I have consulted to law firms and citizen groups regarding Steam Generators, Thermal Hydraulics, Corrosion , and Material Fatigue in connection with license renewals and a power upgrades.

2. Non Nuclear Related Experience

I am the owner and the CEO of a small Maryland company, Noverflo, Noverflo is developing advanced fiber optic sensors for the oil & gas and the environmental monitoring industries. In 2004 Noverflo has completed a three year program which was sponsored by the U.S. Department of Energy. The program produced a new system for automatic tank gauging, which will be presented at the 2006 National Petrochemicals and Refiners Association Maintenance Conference.

In 1994-1996 Noverflo has developed and commercialized a shutoff valve for fuel tanks to comply with new EPA regulations.

E. Brief Employment History

A. Recent Consulting

1. Winston & Strawn , 1400 L St. Washington D.C

2001

Provided assistance in connection with the February 2000 steam generator event at Indian Point.

2. C-10 Research and Education Foundation, Inc. 44Merrimac St. Newburyport, MA

2002-2003

Provided assistance in the preparation of a 2.206 petition to the NRC and other matters in connection with steam generator problems at the Seabrook Station

3. California Earth Corps (Sabrina D. Venskus, Attorney at Law, Santa Monica, CA)
2005

Provided testimony to the Public Utility Commission of the State of California on behalf of California Earth Corps in connection with the San Onofre steam generator replacement project.

4. New England Coalition (Raymond Shadis, Edgecomb, Maine 04556)

2005-2006

Technical consultant and expert witness in connection with Vermont Yankee power uprate and life extension hearings before the **Atomics Safety and Licensing Board.** Prepare contentions and testify before the Board.

B. Industry and Government Employment

1962- 1971 –Corrosion testing of materials for the design and operation of liquid metal cooled nuclear reactors. Modeling Transient Boiling in water and sodium. Modeling Sodium Fires. Modeling destruction of SNAP fuel rods on reentry into the earth atmosphere. Atomics International, Canoga Park, Calif.

1971- 1973- Participated in the resolution of design issues as related to material behavior in the Breeder reactor environment. Atomic Energy Commission

1973 – 1978 Project Manager for the safety evaluation and testing of steam generators for liquid metal reactors. Managed the development of thermal –hydraulic computer codes such as COBRA. ERDA/Department of Energy. Responsible for testing material compatibility and cavitation damage in sodium. Development of acoustic leak detection systems for sodium/water reactions.

1978 – 1982 Project Manager for the development of materials and instrumentation for high temperature steam generators for fossil plants. Responsible for the resolution of issues relating to corrosion/erosion and NOx /SOx emissions, Department of Energy.

1982 – 2001 Program manager for the resolution of various, thermal hydraulics, material corrosion and safety issues primarily in relation to PWR steam generators. Nuclear Regulatory Commission.

Publications

In addition to numerous reports, I have published 15 papers in peer-reviewed technical journals in the areas of thermal-hydraulics, corrosion/ erosion, steam generator dose releases during accidents, steam explosions, sensors and ECM machining.

Peer Reviewed

1 "New Fiber Optic Based Technology for Automatic Tank Gauging", **Sensors** ,December 2006

2. "Distributed Fiber Optic Sensors for Leak Detection In Landfills", Proceeding of SPIE Vol 3541 (1998)

3. "Continuous Automatic Detection of Pipe Wall Thinning", ASME Proceedings of the 9th, International Conference on Offshore Mechanics and Arctic Engineering. Feb. 1990

4 "Iodine Speciation and Partitioning in PWR Steam Generators", Nuclear Technology, March 1990

5. Comments on "Assessment of Steam Explosion Induced Containment Failures" Letter to the Editor, Nuclear Science and Engineering, Vol. 103, Sept. 1989

6. "Experience and Modeling of Radioactivity Transport Following Steam Generator Tube Rupture", Nuclear Safety, 26,286, 1985

7. "Simplified Correlations for the Predictions of Nox Emissions from Power Plants". AIAA Journal of Energy, Nov.-Dec., 1979

8. "Grain Boundary Grooving of Type 304 Stainless Steel in Armco Iron Due to Liquid Sodium Corrosion", Corrosion, 27, No.11, 428, 1971

9. "Corrosion of Type 316 Stainless Steel with Surface Heat Flux in 1200 Flowing Sodium", Nuclear Engineering and Design, 12; 167-169, 1970

10. "Prediction of the One Dimensional Cutting Gap in Electrochemical Machining", ASME Transaction, J. of Engineering for Industry, p100 (1969)

11. "Electrochemical Machining- Prediction and Correlation of Process Variables", ASME Transactions, J. of Engineering for Industry, 88:455-461, (1966)

12. "Laminar Two-Phase Boundary Layers in Subcooled Liquids", J. of Applied Mathematics and Physics (ZAMP), 15, 388-399 (1964)

13. "Onset of Stable Film Boiling and the Foam Limit", International j. of Heat Transfer and Mass Transfer, 6; 987-989 (1963)) (co-author)

14 "Operating Conditions of Bubble Chamber Liquids", The Review of Scientific Instruments, 34, 308-309. (1963); co-author

15. "Similar Solutions of the Turbulent Free Convention Boundary Layer for an Electrically Conducting Fluid in the Presence of a Magnetic Field," AIAA J. 1:718-719 (1965)

Not Peer Reviewed (Very Recent Publications Only)

New Fiber Optic Based Technology for Automatic Tank Gauging (ATG), NPRA – 2006 Reliability and Maintenance Conference

Automatic Tank Gauging: A New Level of Accuracy; A New Device Promises Greater Accuracy for Custody Transfer by Combining Fiber- Optic Sensing with a Pressure. Sensors Magazine, 12/01/06

PlasticOptical Fibers Sensors for Industrial Process Controls and Environmental Monitoring

List of Patents

1. Automatic Shut-Off Valve for Liquid Storage Tanks, 5,522,415
2. Method and Apparatus for Detecting the Presence of Fluids, 5,200,615
3. Sensors For Detecting Leaks, 5,187,366
4. Method for Monitoring Thinning of Walls and Piping Components 4,922,74
5. Method for Monitoring Thinning of Pipe Walls, 4,779,453
6. Looped Fiber Optic Sensor for the Detection of Substances (5,828,798)
7. Coated Fiber Optic Sensor for The Detection of Substances (5,982,959)
8. Method and Apparatus for Analyzing Information of Sensors Provided Over Multiple Waveguides (6,870,607)

Honors

1. Engineer of Distinction – Published by Engineers Joint Council
2. American men and Women in Science
3. The Blackwall Award for Machine Tools
4. Member Sigma-Xi

Professional Activities

1. Reviewed papers for the ASME Journal and the Journal of Sensors and Actuators
2. Taught a class on Diesel Engines at Montgomery College, Rockville, MD.
3. Served as a member of a Railroad Committee that development a standard for locomotive Fueling
4. Funded and sponsored research and development work at the Engineering Department of the University of Virginia. The research produced a novel method of measuring pipe wall thinning from erosion/corrosion

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	
	Docket No. 50-271-LR
ENTERGY NUCLEAR VERMONT YANKEE, LLC, and ENTERGY NUCLEAR OPERATIONS, INC.	ASLBP No. 06-849-03-LR
	June 20, 2006
(Vermont Yankee Nuclear Power Station)	

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 Häusler, PhD

At Houston, Texas, this 22 day of April, 2008 personally appeared Rudolf Häusler, 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

NOTARY PUBLIC STATE OF TEXAS

JENNIFER JULIANA PEREZ
Notary Public
STATE OF TEXAS
My Comm. Exp. August 22, 2011

Rudolf H. Hausler

SUMMARY

Over 30^+ years planned, conducted, and directed advanced chemical research focused on oil production and processing additives. Acquired expertise in corrosion prevention, chemical inhibition, and materials selection, failure analysis, trouble shooting and economic analysis. Proficient in German, French, and Italian.

EXPERIENCE:

1996 - Present **CORRO-CONSULTA** (Dallas TX, and Kaufman TX)

President private Consulting Company

Consulted with major Oil Companies on selection, testing and application of Oil Field Chemicals, primarily corrosion inhibitors.

- Worked on Global Sourcing Team for Mobil Oil Company (major fulltime 6^+ months study)
- Consulted for Mobil Oil Company on production chemical usage at Mobile Bay sour gas production field and prepared for changeover to alternate chemical supplier (two year project).
- Consulted for Arco Oil company
    - on sour production in Middle East
    - reviewed North Slope corrosion data (statistical evaluation)
- Consulted for Mobil Oil Company at major CO_2 flood in Oklahoma (extensive laboratory and field testing - two major publications)
- Consulted with Teikoku Oil Company (Japanese National Oil Company) on various subjects of
    - drill string corrosion
    - amine unit corrosion of 304 stainless steel
    - corrosion of 13%-Cr in sweet production and the chemical inhibition thereof
    - identifying qualified corrosion testing laboratories in the US and the world
    - application limits for 3% Cr-steels in oil and gas production
- Consulted for Exxon Mobil on new sourcing study for combined Mobile Bay operations. (Developed novel approach for bid procedure and evaluation of bids on purely technical basis. Developed long-range approach to streamlining operations with potentially large savings.)
- Consulting for Oxy Permian Ltd. on major gas gathering system (changing from dry gas gathering to wet gas gathering)
- Prepared several major publications (see list of publications)
- Major consulting contract for ExxonMobil in Indonesia
- Consulting with various smaller Producers in the US (incl. Anadarko Petroleum Corp and Swift Energy Company)

- Consulting with various engineering companies (e.g. Stress Engineering Services Inc.)
- Consultant on call for Blade Energy Partners
- Consulted with various organization concerned with nuclear safety, including the safety of spent fuel storage casks.

1991 - 1995 **MOBIL Oil Company** (Dallas Research Center), Dallas, Texas

Senior Engineering Advisor

Developed corrosion testing facilities for basic research and to meet specific oil field requirements.

- Planned and developed H_2S corrosion test facility
- Planned safety and wrote safety manual
- Developed unique continuous flow-through corrosion test facility ($$ 1.5MM)
- Developed test protocols and supervised operations of the FTTF
- Extensive consultation with Affiliates on problem solving and chemical usage
- Established supplier relationships and consulted with Affiliates on establishing Enhanced Supplier Relationships
- Developed theory and practice of novel approach to autoclave testing

1979 - 1991 **PETROLITE CORPORATION** St. Louis, Missouri

Research Associate 1986 - 1991

Directed and conducted the development of novel corrosion inhibitors for extreme operating conditions

- New corrosion inhibitor to combat erosion corrosion of carbon steel in gas condensate wells
- Extensive studies on CO_2 corrosion aimed at establishing predictive corrosion model
- Developed the only qualified corrosion inhibitor for nuclear steam generator cleaning (EPRI publication NP-3030 June 1983)

Special Assistant to Executive Vice President 1985 - 1987

Special Assignments focused at support of International Sales

- Extensive travel to secure major accounts in Europe, Russia and East Asia
- Monitored out-sourced R&D in Germany and England

Senior Research Scientist 1979 - 1985

- Developed novel chemical composition under contract with EPRI for corrosion inhibition of cleaning fluids used in nuclear steam generators and methodology of application (only effective formulation still used today)
- Developed unique corrosion model for CO_2 corrosion in oil and gas wells
- Conducted numerous detailed field studies to establish case histories of chemical performance and applications technology

1976 - 1979 **Gordon Lab, Inc.,** Great Bend, Kansas

Technical Director

Responsible for all technical issues involving formulation, application and sales of sucker well production chemicals (corrosion, emulsion, scale, bacteria)

- Conducted failure analysis for customers and developed pertinent reports
- Supervised service laboratory
- Established technical training of sales and support personnel
- Developed technical sales literature and company brochure

1963 - 1976 **UOP (a division of SIGNAL COMPANIES)** Des Plaines, Illinois

Research Associate	1972 - 1976
Associate Research Coordinator	1967 - 1972
Research Chemist	1963 - 1967

To conduct research in electrochemistry, analytical methods development, heat exchanger fouling processes and refinery process additives

- Developed novel organic electrochemical synthesis procedure
- Developed unique (patented) test apparatus for measuring anti-foulant activity
- Introduced statistical design and evaluation of experiments to R&D department and Developed 20 hr course on statistics.
- Developed full 3 credit hour corrosion course to be taught at IIT and DeSoto Chemical Company

EDUCATION

- Ph.D. Chemical Engineering; Swiss Federal Institute of Technology, Zurich Switzerland
- BS, MS Chemical Process Technology, same as above

PROFESSIONAL ASSOCIATION

- American Chemical Society
- The Electrochemical Society
- Society of Petroleum Engineers
- NACE International (Corrosion Engineers)
- American Society fro Metals (ASM)

- Active in NACE on local, regional and national level

RECOGNITION
- NACE Technical Achievement Award (1990)
- NACE Fellow Award 2003

ACHIEVEMENTS
- 17 patents, 58 publications and more than 100 technical presentations
- Registered Professional Engineer (Corrosion Branch, California)
- NACE certified Corrosion Specialist

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

Alex S. Karlin, Chairman
Dr. Richard E. Wardwell
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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.

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.

U Witte

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

Danette Broadhurst

Notary Public

My Commission Expires 8-31-2011

Ulrich K. Witte

Summary:

Over twenty-six year's of professional experience in engineering, configuration management, licensing, regulatory compliance of large scale commercial nuclear facilities. This includes management and implementation of design change control programs, engineering standards programs, multi-department/multi-functional licensing initiatives, plant design basis and engineering process improvement programs for six energy companies operating seven nuclear power plants. Responsibilities include:

- Systems solutions to plant operations, engineering modifications, safety analyses, design changes, installation and testing, software, drawing change programs, and training. Optimized function interfaces to insure proper coordination and synchronization for cost effective and compliant operation of the facility.
- Technical support management, and issue resolution programs that identified potential hardware, operational or equipment function issues, as well as document problems, data management problems and organizational enhancements
- Engineering Change Processes from change inception to document close-out
- Multi-department Configuration Management Program including technical approach, consensus, approval, and implementation. Managed a standing Configuration Management Programs Group whose goal was to integrate ten functional areas under a corporate strategic plan encompassing two nuclear facilities.
- Vertical slice system design/operation reviews, design bases / regulatory rule reconciliation, and licensing bases reconstitution and transitioning projects
- Integration of plant equipment information systems with business processes within engineering, materials management, maintenance, and plant operations.
- Structured business process modeling. Application of functional analysis purely from a data prospective—to enhance change management, efficiency.
- Chaired ANSI certified industry guidance on cost effective, compliant, and institutionalized programs for successful configuration management enhancement
- EPRI guidance on optimizing the Engineering Change Process
- Formal training to engineering department personal with specific courses on the engineering change process, plant safety analysis, and modification testing. Trained engineering personal on the requirements of the plant wide Configuration Management Program.

Technical Consultant

Northern Lights Engineering, L.L.C., 71 Edgewood Way, Westville, Connecticut 06515 (May 2002 –Today)

Established a consulting practice where I provided expertise in matters affecting the safe operation and regulatory compliance of commercial nuclear power facilities. This includes licensing and regulatory compliance issues, modification and implementation of industry standards, engineering design reviews, and configuration management analysis associated with an unexpected event, a design failure, or an elevated risk condition, and includes review of proposed changes to the plant operating license in preserving design efficacy.

Technical Advisor and Expert Witness to IPSEC representing WestCAN, Clearwater, the Sierra Club - Atlantic Chapter, and PHASE

Providing technical advisory, expert witness work and legal assistance in preparing and submitting petition for leave to intervene and request for hearing with contentions regarding the license renewal application by Licensee for Indian Point Nuclear Units 2 and 3. This included preparing and filing an initial petition containing 51 contentions and several other petitions regarding fire protection for Unit 3, in context with the recent EPA letter, as well as Mothers v. NRC filed in 9th circuit, and the October 31 DEC/AG letter. The work includes, separate allegations of regulatory procedural violations regarding the Thermal Shock Proposed Rule, and recent Fire Protection Exemptions that appear to clearly violate to CFR Part 2, and the Design Basis Threat rule under 10CFR73. This effort includes expert review of the Aging Review Program, in particular flow-accelerated corrosion issues, and finite element fatigue analysis reviews of susceptible components and a number of other contentions related to the safe operation of each unit beyond its 40 year license.

Technical Advisor and Expert Witness to the law firm of Shems, Dunkiel, Kassel, & Saunders, PLLC

Currently providing technical assistance in pre-filed testimony regarding Entergy Nuclear Operations application for renewing the operating license of Vermont Yankee. This includes Aging Review Program, in particular flow-accelerated corrosion issues, and finite element fatigue analysis reviews of susceptible components and a number of other contentions related to the safe operation of the plant beyond its 40 year license at 120% of originally design power

Technical Advisor, to the law firm of Leroche, Meyers, and Conswel, LLP.

Provided licensing and regulatory compliance expertise in legal claim and derivative action by the board of directors of the First Energy Corporation against its corporate officers in their role associated with the Northeast black out of August 2003, and the mismanagement of the Davis Besse Nuclear Power Plant.

Technical Advisor to the Union of Concerned Scientists

Provided technical review of UCS analysis of the Davis Besse reactor head corrosion event. This included analysis of the loss of integrity of the reactor vessel, and the immediacy of the reactor head failure.

Senior Scientist, Dominion Resources Inc, Millstone Station:

P.O. Box 128, Waterford, Connecticut 06385-0128 (December 1996 – 2002)

Project Manager, Licensing Commitments. Established the Regulatory Commitment Management Program. Developed a program that established senior management and department level control of more than 30,000 licensing commitment that was previously broken. The substantially enhanced program captured, dispositioned, consolidated, and managed implementation of docketed commitments to the NRC. Status, responsibility and clear communication were successfully implemented to allow Millstone to successfully restart Units 2 and 3.

The effort required substantial procedure revisions, customer consensus building, and integration of separate free-standing department specific database applications, as well as the station wide action item tracking system. A near term deliverable necessary for the successful restart of Unit 3 was to provide a workable, compliant and functioning regulatory commitment management program.

Project Manager, 50.54(f) Licensing Bases Transition Project. I led a team of 14 individuals to disposition and validate approximately 5100 regulatory commitments necessary for restart of Unit 3. The effort has led to a quality rate of more than 98 percent with production average of about four hours per commitment.

Manager, Configuration Management Program, New York Power Authority

123 Main Street, White Plains New York 10621, Nuclear Generation Department, Engineering Division
(November 1991 - November 1996)

Established the Configuration Management Program for the New York Power Authority's nuclear facilities. Included are 10 functional areas and integrated controls as authored in the corporate strategic plan. Management functions and technical skills include the following:

- Established Configuration Programs Group. This group and my position were established as a result of INPO Plant Evaluation calling for configuration management enhancement, and resolution of design control issues identified by the NRC in their DET Inspection of 1991 of the FitzPatrick Plant, as well as independent assessments. Recruited permanent staff, and supplemented the group with contracted staff on as needed basis to support both plants correcting significant technical and functional issues and being placed on the NRC's Watch List.

- Modified the engineering change process. Areas of immediate attention included the Design Control and Modification Programs, where a series of working groups were established to correct technical content and improve quality, ownership, and business efficiency of the design change process. This effort was achieved via: (1) a formal process to assess, model, and enhance the design change and modification process and interfaces to key functions; and (2) immediate changes to engineering procedures.

- Assessed and enhanced the Plant Equipment Data Base and controls for each plant. Results of the assessment indicated that the IP3 Plant Equipment Database contained significant problems with component classification, equipment type and status, maintenance history etc. Prepared and implemented a recovery plan and project team to reestablish the controls and content of database to be compliant with NRC Generic Letter 83-28 and to support the plant restart. Streamlined and enhanced the component classification process for both plants. Established controlled and non-controlled segregation of plant equipment in accordance with recent EPRI guidance.

- Automated and validated existing fragmented and corrupt sources of engineering information. These data sources were compiled, validated, and controlled and included multi-department areas such as set point controls, Electrical Cable and Raceway Information Systems for JAF and IP3, along with the fuse controls and data management.

- Developed design basis problem resolution process, "Design Document Open Item". Established methods for prioritizing, tracking and closing out design document issues. Established proper interface and control room notifications as per tech spec requirements. Provided guidance on operability determinations and reportability. Provided oversight for classifying and tracking more than 1100 open design issues for IP3 and 300 for JAF. Defended program to the NRC.
- Established working groups between Nuclear Generation Department and the corporate wide Information Management Organization. Gained management endorsement for areas of data quality improvement and automation for the Nuclear Generation Department. This led to enhanced implementation of the equipment information systems for both sites.

Project Manager, Program to Assure Completion and Quality, Tennessee Valley Authority:

(December 1990 - March 1991) Under contract by CYGNA Energy Services to the Vice-President, Engineering and Operations Department, Watts Bar Nuclear Plant.

- Developed a comprehensive plan to measure progress and confirm quality of the in-progress design evolution of the plant. Developed a methodology for linking specific plant equipment to that equipment's respective design basis (and associated design attributes); license commitments; and numerous verification programs currently in place. The five phase program was presented to NRR in January and received approval as an activity to assist TVA in removing the stop work order on construction of the facility.

Technical Manager, Configuration Management Program, Southern Nuclear Operating Company:

(December 1988 - November 1991). Under contract by ABB Impell and CYGNA Energy Services to Corporate Engineering Manager, Edwin I. Hatch Nuclear Plant, Georgia Power Company.

- Established and implemented the Hatch Configuration Management Program. Phase one of the effort included definition, establishment of management objectives, specification of the configuration management program scope and development of a reference manual.
- Developed and executed formal rigorous horizontal evaluations (the second phase of the project) of each relevant functional area including engineering design, implementation, plant operations and maintenance, procurement, information systems, document control and others. The program integrates functional areas across the plant, each architect engineer, and corporate (SONOPCO and Southern Company Services) organizations.
- Implemented enhancements to the program. This phase includes upgrading the design change process to achieve successful integration across organizations; stricter adherence to closure activities; and formal design engineering involvement in such activities as procurement of replacement items (equivalency). Additional controls were established such that misapplication of information obtained through informal design change processes such as the "Request for Engineering Assistance".
- Reconciling the plant's design basis. A second major activity of the program was to compile, consolidate, and ultimately, automate the plant's design basis. A major objective is to provide access and retrievability of current design basis to each of the key users of each participant organization.

- Applied Structured Business Analysis including CASE tools in the evaluation and enhancement phases. The as-found configuration management activities of all relevant processes were modeled and analyzed with this technique. Proposed enhancements are then tested on the model prior to actual implementation.
- Chaired the subcommittee for the Nuclear Information and Records Management Association which is developing a Technical Position Paper entitled, "Implementation of a Configuration Management Enhancement Program for a Nuclear Facility".

Team Leader, NRC Safety System Functional Inspection Response Organizations:

Led the NRC Safety System Functional Inspection Response Teams for Georgia Power Company (1989), and Sacramento Municipal Utility District (1987). Assisted as team coordinator in the GPC - Plant Hatch Electrical Distribution System Functional Inspection Response Team (1991). Under contract by ABB Impell (December 1987 - November 1990) to the site Engineering Manager, Rancho Seco, SMUD. and CYGNA Energy Services (December 1990 - November 1991) to the Corporate Engineering Manager, Edwin I. Hatch Nuclear Plant, Georgia Power Company.

- In the case of GPC, the NRC SSFI resulted in validation of the in progress implementation of the Hatch Configuration Management Program, and only one violation to the licensee.
- The effort included an SSFI self-assessment as well as managing the utility through the NRC inspection.
- For SMUD, developed and executed a plan for closure of both immediate findings and long term corrective action required. Assisted in defending the plan to the NRC.
- For GPC - Plant Hatch EDSFI in June 1991. Developed and implemented an EDSFI Preparation Plan for the Engineering (both A/Es) and site organizations. This effort included management of a 27 man team preparation and inspection response team for the Hatch EDSFI.

Deputy Mechanical Engineering Manager, Engineering Department

Under Contract to the Site Engineering Manager, Rancho Seco, Sacramento Municipal Utilities District, Rancho Seco (April 1986 - September 1987)

Managed the implementation and closure of over 400 modifications to the plant. Provided the NRC with a basis for allowing a successful restart of the facility. (January 1986 to November 1986) Impell Lead Project Engineer, Class 1 Piping and Support Recertification Effort, SMUD.

- Developed an engineering department action plan to improve technical quality, reconstitute design basis for five systems, control costs of plant modifications, and improve adherence to schedule.
- Responsible for the complete recertification of the Pressurizer Relief Line, Decay Heat System, and others. Responsible for expediting and implementing design changes as necessary through to closure. Assisted in Utility responses to NUREG-0737, and I&E 79-14.
- Upgraded the Engineering Department procedures to gain credit for the relaxation of ASME code requirements in structural damping values. Initiated the FSAR changes as well.

Project Engineer, Fire Protection:

Under Contract to Sacramento Municipal Utilities District, Rancho Seco (November 1984 to April 1986), SMUD Fire Protection Coordinator, Fire Protection Program

- Developed the SMUD Appendix R Fire Protection Program. Established or substantially revised 110 plant and engineering procedures including shutdown procedures on total loss of the plant's control room; technical specification surveillance procedures, fire protection system maintenance procedures, and the development of a fire protection program manual.

Successfully defended the program to the NRC during the 1985 Appendix R Inspection, with no resulting findings or open items.

Additional Experience (6/78 through 8/84):

Senior Engineer, performed original pipe stress analysis and support placement for Duke Power's Catawba Plant. Qualified approximately 8 class one and two plant systems. (ABB Impell 6/78 - 12/79).

Non-linear finite element analysis of large diameter piping for EPRI. Analysis of production stress codes versus non-linear evaluation techniques, versus actual in situ testing of the system. Results were published in EPRI Report "Seismic Piping Test and Analysis. (ABB Impell, 1980 -1981)

As Project Engineer, directed the preparation of the annual Emergency Plan exercises for Kansas Gas and Electric Company, Union Electric Company, and Texas Utilities. In two plants, the exercise was installed on the plants simulator, and received recognition from the NRC for realism of the scenario. (ABB Impell 1982-1984).

EMPLOYER SUMMARY:

Northern Lights Engineering, L.L.C. 12/2002 – current
71 Edgewood Way
Westville, CT 06515

Northeast Utilities /Dominion Resources Inc 12/1996 – 12/2002
(Under Contract via Cataract Inc through 9/97.)
2500 McClellan Ave.
Pennsauken, NJ 08109

New York Power Authority 11/1992 -12/1996
123 Main Street
White Plains, New York 10671

Cygna Energy Services 11/1991 - 11/1992
5600 Glenridge Drive, Suite 380
Atlanta, Georgia 30075

ABB Impell Corporation 6/1978 - 11/1991
333 Research Court
Technology Park-Atlanta
Norcross, Georgia 30095

EDUCATION:
University of California, Berkeley
B.A. Physics, 1983
Senior level and graduate course work in Mechanical Engineering, and Electrical Engineering

Quinnipiac University School of Law
J.D expected June, 2009

PUBLICATIONS:
- EPRI Report Number 108736, "Guidelines for the Optimization of the Engineering Change Process," March 1994.
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PROFESSIONAL AFFILIATIONS AND AWARDS
American Society of Mechanical Engineers, American Nuclear Society, Nuclear Information and Records Management Association, Who's Who For Rising Young Americans.

REFERENCES:
References available upon request.

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)	)	

CERTIFICATE OF SERVICE

I, Christina Nielsen, hereby certify that copies of NEW ENGLAND COALITION, INC.'S INITIAL STATEMENT OF POSITION, DIRECT TESTIMONY AND EXHIBITS in the above-captioned proceeding were served on the persons listed below, by U.S. Mail, first class, postage prepaid and, where indicated by an e-mail address below, by electronic mail, on April 28, 2008.

Administrative Judge
Alex S. Karlin, Esq., Chair
Atomic Safety and Licensing Board
Mail Stop T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: ask2@nrc.gov

Administrative Judge
William H. Reed
1819 Edgewood Lane
Charlottesville, VA 22902
E-mail: whrcville@embarqmail.com

Office of Commission Appellate Adjudication
Mail Stop: O-16C1
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: OCAAmail@nrc.gov

Administrative Judge
Dr. Richard E. Wardwell
Atomic Safety and Licensing Board Panel
Mail Stop T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: rew@nrc.gov

Office of the Secretary
Attn: Rulemaking and Adjudications Staff
Mail Stop: O-16C1
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: hearingdocket@nrc.gov

Sarah Hofmann, Esq.
Director of Public Advocacy
Department of Public Service
112 State Street, Drawer 20
Montpelier, VT 05620-2601
E-mail: sarah.hofmann@state.vt.us

Lloyd B. Subin, Esq.
Mary C. Baty, Esq.
Office of the General Counsel
Mail Stop O-15 D21
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: lbs3@nrc.gov; mcb1@nrc.gov

Anthony Z. Roisman, Esq.
National Legal Scholars Law Firm
84 East Thetford Road
Lyme, NH 03768
E-mail: aroisman@nationallegalscholars.com

Marcia Carpentier, Esq.
Atomic Safety and Licensing Board Panel
Mail Stop T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail mxc7@nrc.gov

Peter C. L. Roth, Esq.
Office of the Attorney General
33 Capitol Street
Concord, NH 03301
Peter.roth@doj.nh.gov

David R. Lewis, Esq.
Matias F. Travieso-Diaz
Pillsbury Winthrop Shaw Pittman LLP
2300 N Street NW
Washington, DC 20037-1128
E-mail: david.lewis@pillsburylaw.com
matias.travieso-diaz@pillsburylaw.com

Christina Nielsen

by: Christina Nielsen
Christina Nielsen, Administrative Assistant
SHEMS DUNKIEL KASSEL & SAUNDERS PLLC