

May 13, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

NRC STAFF INITIAL STATEMENT
OF POSITION ON NEC CONTENTIONS 2A, 2B, 3, and 4

INTRODUCTION

Pursuant to 10 C.F.R. §§ 2.1207(a)(1) and 2.337(g)(2), Order (Regarding the Record for the Evidentiary Hearing (April 3, 2008) (unpublished); and Initial Scheduling Order (Nov. 17, 2006) (unpublished) at 10, the Staff of the U.S. Nuclear Regulatory Commission (“Staff”) submits its initial written statements of position and written testimony with supporting affidavits on New England Coalition’s (“NEC”) admitted contentions. Appended to this filing is the “NRC Staff Testimony of Kenneth C. Chang Regarding NEC Contentions 2A & 2B;” “NRC Staff Testimony of John R. Fair Regarding NEC Contentions 2A & 2B;” “NRC Staff Testimony of Kiahwa R. Hsu, Jonathan G. Rowley, and Thomas G. Scarbrough Regarding NEC Contention 3;” “NRC Staff Testimony of Kiahwa R. Hsu and Jonathan G. Rowley Regarding NEC Contention 4;” and 23 Staff Exhibits. For the reasons set forth below and in the testimony filed herewith, the Staff submits that a careful evaluation of NEC’s contentions demonstrates that its challenge to the Entergy Nuclear Vermont Yankee LLC, and Entergy Nuclear Operations, Inc (“Entergy”) application for renewal of the Vermont Yankee operating license cannot be sustained.

BACKGROUND

This proceeding concerns Entergy's application to renew Vermont Yankee's operating license for 20 years. On May 26, 2006, NEC filed a timely request for hearing concerning Entergy's application to renew the Vermont Yankee operating license for 20 years past the March 12, 2012 expiration date. On September 22, 2006, the Atomic Safety and Licensing Board ("Board") granted NEC's intervention petition, admitting three¹ contentions:

- Contention 2: 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 under 10 C.F.R. § 54.21(c).²
- Contention 3: Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation.
- Contention 4: Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of plant piping due to flow-accelerated corrosion during the period of extended operation.

See LBP-06-20, 64 NRC 131, 183-196 (2006).³

A. NEC Contention 2 (Metal Fatigue)

In admitting NEC Contention 2, the Board found that NEC had demonstrated a genuine material dispute "by raising the question of whether Entergy's 'plan to develop a plan' to

¹ The Board also admitted NEC Contention 1 alleging that Entergy failed to assess impacts to water Quality and Vermont Department of Public Service ("DPS") Contention 1 regarding aging management of Vermont Yankee's primary containment concrete. LBP-06-20, 64 NRC at 175-82;162-67. The Commission reversed the Board's decision to admit NEC Contention 1. CLI-07-16, 65 NRC 371 (2007). Entergy and DPS settled DPS Contention 1. Order (Approving Settlement of DPS Contention 1) (May 31, 2007) (unpublished).

² In accordance with "Memorandum and Order (Ruling on NEC Motions to File and Admit New Contention) (November 7, 2007), this contention is being held in abeyance. The parties are litigating NEC Contention 2A, which challenges the adequacy of Entergy's reanalysis of the environmentally adjusted cumulative usage factors of key reactor components.

³ Also in LBP-06-20, the Board granted NEC's and DPS's notices of adoption of each other's contentions to the extent that NEC's and DPS's contentions were admitted. LBP-06-20, 64 NRC at 208

manage environmentally assisted metal fatigue is sufficient to meet the license renewal requirements of 10 C.F.R. § 54.21(c)(i)-(iii).” LBP-06-20, 64 NRC at 186. The Board so found because, in its LRA, Entergy stated it was relying upon 10 C.F.R. § 54.21(c)(1)(iii) (i.e., demonstrating that the effects of aging will be adequately managed), but its application contained only a summary of “options for future plans rather than demonstrating compliance” with § 54.21(c)(1)(iii). *Id.*

Subsequently, Entergy informed the Staff that it was performing a reanalysis of the CUFs at fatigue sensitive locations to demonstrate that the CUFs will be less than unity (1.0) throughout the period of extended operations. See LBP-07-15, 6 NRC 261, 265 (2007); Vermont Yankee Nuclear Power Station License No. DPR-28 (Docket No. 50-271) License Renewal Application, Amendment 28 (July 30, 2007) (ML072140847). Entergy performed the reanalysis, disclosing to the parties the preliminary results on June 7 and 13, 2007, and the final results on August 8, 2007. November 7 Order at 4. Entergy formally docketed its reanalysis on September 17, 2007. See Vermont Yankee Nuclear Power Station License No. DPR-28 (Docket No. 50-271) License Renewal Application Amendment 31 (ML072670135) (Staff Exh. 22).

On July 12 and September 4, 2007, NEC filed motions to file a timely new or amended contention regarding Entergy’s program to manage the aging effects of metal fatigue, claiming that Entergy’s reanalysis was flawed and thus failed to meet the requirements of 10 C.F.R. § 54.21. See New England Coalition, Inc’s (NEC) Motion to File a Timely New or Amended Contention (July 12, 2007) (“July 12 Motion”); New England Coalition, Inc’s (NEC) Motion to File a Timely New or Amended Contention (September 4, 2007) (“September 4 Motion”). The Staff did not oppose NEC’s motions. See NRC Staff Answer to NEC Motion to File a Timely New or Amended Contention (August 6, 2007); NRC Staff Answer to NRC Motion to File a Timely New or Amended Contention (October 1, 2007). Entergy did not oppose NEC’s July 12 Motion,

however, Entergy requested that the Board dismiss NEC Contention 2 as admitted by the Board in LBP-06-20 and withhold a ruling on the July 12 Motion until Entergy's reanalysis was finalized. See Entergy's Response to NEC's Motion to File a New or Amended Contention (August 6, 2007). Entergy opposed NEC's September 4 Motion and resubmitted that the Board should dismiss NEC Contention 2 as admitted by the Board in LBP-06-20. See Entergy's Response to NEC's Motion to File a Timely New or Amended Contention (October 1, 2007).

In LBP-07-15, the Board admitted NEC's new contention (identifying it as NEC 2A) alleging: the "analytical techniques 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 assessed will not fail due to metal fatigue during the period of extended operation." The Board viewed Contention 2A as a critique of Entergy's calculation of environmental fatigue correction factors (Fens) and a critique of Entergy's 60-year CUFs. LBP-07-16, 66 NRC at 270 (*citing* Sixth Declaration of Dr. Joram Hopfenfeld ¶¶14-18 and 19-26. The Board ordered that the parties litigate NEC's new contention, NEC Contention 2A, holding NEC Contention 2 in abeyance. *Id.* at 271.

In response to requests for additional information from the Staff, Entergy performed an additional analysis of the CUFen for the feedwater nozzle, which became the "analysis of record."⁴ See Letter, Entergy to USNRC, "License Renewal Application, Amendment 34," BVY 08-002 (Jan. 30, 2008) (Exh. NEC-JH_34); Letter Entergy to USNRC, "License Renewal Application Amendment 36," BVY 08-012 (Feb. 21, 2008) (Staff Exh. 23). On March 17, 2008,

⁴ This analysis has also been referred to as the "confirmatory analysis" by Entergy and the Staff, the "updated analysis" by the Staff in NUREG-1907, Safety Evaluation Report Related to the License Renewal of Vermont Yankee Power Station (Feb. 2008) (Staff Exh. 1), and "Second Reanalysis" by NEC.

NEC filed a Motion to File a Timely New or Amended Contention (“March 17 Amendment”), seeking to leave to file a new or amended contention on metal fatigue addressing Entergy’s “analysis of record.” On April 24, 2008, the Board issued an “Order (Granting Motion to Amend NEC Contention 2A)” (unpublished) (“April 24 Order”). In the Order, the Board deemed NEC’s April 17 Amendment to be “a subset of Contention 2A” designed to prevent NEC from being foreclosed from challenging Entergy’s CUF analysis of record. April 24 Order at 2. Because the deadline for NEC to file its initial statements of position was approaching, the Board did not endeavor to restate Contention 2A or NEC’s March 17 Amendment, instead, the Board designated NEC’s March 17 Amendment Contention 2B. *Id.*

B. NEC Contention 3 (Steam Dryer)

In admitting NEC Contention 3, the Board found that Contention 3 was supported by Dr. Hopenfeld’s First Declaration, specifically ¶¶18 and 19, and concluded that NEC had “identified sufficient ambiguity in Entergy’s aging management plan . . . to meet the requirements for admissibility.” LBP-06-20, 64 NRC at 191.

On April 19, 2007, Entergy filed a motion for summary disposition of NEC’s Contention 3 (Steam Dryer). See Entergy’s Motion for Summary Disposition of New England Coalition’s Contention 3 (Steam Dryer) (April 19, 2007). The Staff supported Entergy’s motion. See NRC Staff Answer in Support of Entergy’s Motion for Summary Disposition of New England Coalition Contention 3 (Steam Dryer) (May 9, 2007). NEC opposed Entergy’s motion. See “New England Coalition, Inc.’s (NEC) Opposition to Entergy’s Motion for Summary Disposition of NEC’s Contention 3 (Steam Dryer) (May 9, 2007); “New England Coalition, Inc.’s (NEC) Supplement to Opposition to Entergy’s Motion for Summary Disposition of New England

Coalition Contention 3 (Steam Dryer) (July 19, 2007) (“July 19 Supplement”).⁵ Entergy and the Staff responded to NEC’s supplement. See Entergy’s Response to New England Coalition’s Supplement to Opposition to Entergy’s Motion for Summary Disposition of New England Coalition Contention 3 (Steam Dryer) (July 26, 2007); NRC Staff Answer to NEC’s Supplement to Opposition to Entergy’s Motion for Summary Disposition of NEC Contention 3 (Steam Dryer) (July 26, 2007).

In “Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 3)” (September 11, 2007) (unpublished) (“NEC 3 SD Order”) the Board granted in part and denied in part Entergy’s motion. The Board granted Entergy’s motion:

(1) as it relates to the specific use and benchmarking of the CFD and ACM computer models in monitoring potential steam dryer cracking, and (2) as it relates to NEC’s inference that the steam dryer is not continuously monitoring as part of the aging management program for the license renewal period.”

NEC 3 SD Order at 3. The Board so ruled because Entergy “flatly represented to the Board that that [Computational Fluid Dynamic] and [Acoustic Circuit] models will not be used or relied upon [to monitor potential steam dryer cracking] and that the steam dryer will be continuously monitored.” *Id.* at 3. The Board denied Entergy’s motion as it related to NEC’s assertion “that the status of the steam dryer must be continuously monitored and assessed by a competent engineer” because Entergy did not provide information regarding the qualifications of the personnel performing the monitoring. *Id.* at 11. The Board also denied Entergy’s motion as it related to asserted inadequacies in “Entergy’s assessment of the monitoring data collected from

⁵ In “Order (Granting Motion to Defer and Setting Schedule) (July 13, 2007) (unpublished), the Board granted NEC’s request that the Board defer its decision on Entergy’s motion for summary disposition until the results of the May 2007 Steam Dryer inspection were available and allow NEC to file a supplemental response to Entergy’s motion for summary disposition. Therein the Board authorized the Staff and Entergy to respond to any supplement filed by NEC.

the aging management program for the steam dryer” and failure to include some form of stress load analysis in its program. *Id.* 13-14.

In addition, the Board noted that NEC’s July 19 Supplement provided no additional insight and the Second Declaration of Ulrich Witte, attached thereto, was inconclusive and “failed to provide a nexus between [the May 2007 steam dryer inspection results] and the adequacy of Entergy’s aging management plan.” *Id.* at 12.

C. NEC 4 (Flow-Accelerated Corrosion)

In admitting NEC Contention 4, the Board found that the contention was supported by ¶ 24 of the Declaration of Dr. Joram Hopenfeld (May 12, 2006). The issue raised by NEC Contention 4 is whether Entergy’s plan to monitor and manage the aging of plant piping due to flow-accelerated corrosion at Vermont Yankee is inadequate because it relies on CHECWORKS, an “empirical code,” used to determine the scope and frequency of inspection of susceptible components, a code which “must be continuously updated with plant-specific data,” and a code that “has not been benchmarked with data” reflecting parameter changes associated with Vermont Yankee’s extended power uprate (EPU). See LBP-06-20, 64 NRC at 192-194.

On June 5, 2007, Entergy filed a motion for summary disposition of NEC Contention 4. See Entergy’s Motion for Summary Disposition of New England Coalition’s Contention 4 (Flow Accelerated Corrosion). The Staff supported Entergy’s motion. See NRC Staff Answer in Support of Entergy’s Motion for Summary Disposition of NEC Contention 4 (Flow-Accelerated Corrosion) (June 25, 2007). NEC opposed. See New England Coalition, Inc.’s (NEC) Opposition to Entergy’s Motion for Summary Disposition of NEC’s Contention 4 (Flow-Accelerated Corrosion) (July 16, 2007).

In “Memorandum and Order (Ruling on Motion for Summary Disposition of NEC 4)” (August 10, 2007) (unpublished) (“August 10 Order”), the Board denied Entergy’s motion for summary disposition concluding that pleadings revealed a “classic battle of the experts:”

Entergy's experts assert that extensive benchmarking is not necessary and the data from three refuelling outages at EPU conditions is sufficient; NEC's expert asserts, that 10-15 years worth of data is necessary. See August 10 Order at 2, 7.

DISCUSSION

I. Legal and Regulatory Requirements

The scope of license renewal proceedings is limited. The Commission's "[l]icense renewal reviews are not intended to 'duplicate the Commission's ongoing review of operating reactors.'" *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 & 4), CLI-01-17, 54 NRC 3, 7 (2001) (citing Final Rule, "Nuclear Power Plant License Renewal," 56 Fed. Reg. 64,943, 64,946 (Dec. 13, 1991)). Therefore, the license renewal safety review process focuses on the "potential detrimental effects of aging that are not routinely addressed by ongoing regulatory oversight programs." *Id.* Pursuant to 10 C.F.R. § 54.21(a)(3), license renewal applicants are required to "demonstrate that the intended function(s) will be maintained consistent with the CLB for the period of extended operation." Pursuant to 10 C.F.R. § 54.21(c), license renewal applicants must demonstrate that they have reassessed any health and safety analyses performed during the initial licensing process that were limited to the initial 40-year licensing period, and that those analyses are valid for the period of extended operation. *AmerGen Energy Co. LLC* (Oyster Creek Nuclear Generating Station), CLI-06-24, 64 NRC 111, 117 (2006).

The Commission has recognized that these "adverse aging effects generally are gradual and thus can be detected by programs that ensure sufficient inspections and testing." *Id.* (citing 60 Fed. Reg. at 22,475). License renewal proceedings are limited to a "review of the plant structures and components that will require an aging management review for the period of extended operation and 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 and 2; Catawba Nuclear Station, Units 1 and 2), CLI-01-20, 54 NRC 211, 212 (2001) (citing 10 C.F.R. §§ 54.21(a) and (c), 54.4; Final Rule, “Nuclear Power Plant License Renewal: Revisions,” 60 Fed. Reg. 22,461 (1995)).

The issues before the Board in this proceeding are the adequacy of Vermont Yankee’s fatigue monitoring program (Contentions 2A and 2B), steam dryer monitoring program (Contention 3), and flow-accelerated corrosion program (Contention 4). The adequacy of the Staff’s review of Vermont Yankee’s LRA is not at issue. See Rules of Practice for Domestic Licensing Proceedings-Procedural Changes in the Hearing Process, Final Rule, 54 Fed Reg. 33168, 33171 (Aug. 11, 1989) (citing *Pacific Gas and Electric Co.* (Diablo Canyon Nuclear Power Plant, Units 1 and 2), ALAB-728, 17 NRC 777, 807, *review declined*, CLI-83-82, 18 NRC 1309 (1983)). Also not at issue is whether Vermont Yankee is in compliance with its current licensing basis (“CLB”)⁶. See Final Rule, “Nuclear Power Plant License Renewal; Revisions,” 60 Fed. Reg. 22,461, 22473 (May 8, 1995).

The overall burden is on Entergy to demonstrate the adequacy of its aging management programs challenged by NEC’s admitted contentions. See 10 C.F.R. § 2.325. NEC, however, must come forward with evidence, *i.e.*, that Entergy’s programs and/or its reanalysis are inadequate. *Louisiana Power & Light Co.* (Waterford Steam Electric Station, Unit 3), ALAB-732,

⁶ CLB is defined in 10 C.F.R. § 54.3 as:

[T]he set of NRC requirements applicable to a specific plant and a licensee’s written commitments ensuring compliance with and operation within the 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.

17 NRC 1076, 1093 (1983).

The Commission's requirements with respect to the adequacy of Entergy's programs to monitor and manage metal fatigue, the aging of the steam dryer, and the effects flow-accelerated corrosion on plant piping during the license renewal period are described in the testimony filed herein. Specifically, as set forth in the Staff's NUREG-1907, "Safety Evaluation Report Related to the License Renewal of Vermont Yankee" (Feb. 25, 2008) ("SER") (Staff Exh. 1), the applicable legal standard for the Staff's approval of Vermont Yankee's aging management programs is 10 C.F.R. § 54.21(a)(3), i.e. whether Entergy has demonstrated that the aging on the steam dryer and the aging effects of flow-accelerated corrosion on reactor coolant pressure boundary piping will be adequately managed so that the intended functions of the steam dryer and the reactor coolant pressure boundary will be maintained consistent with the CLB for the period of extended operation. One way for a licensee to make the demonstration required by § 54.21(a)(3), is to commit to following the guidance provided by NUREG-1801, Rev. 1, "Generic Aging Lessons Learned (GALL) Report" ("GALL"). Entergy has represented that its programs for managing the effects of flow-accelerated corrosion are consistent with GALL. Therefore, the Staff reviewed Entergy's program to determine consistency with GALL. See SER Section 3.0.3.1.2 (flow-accelerated corrosion) (Staff Exh. 1).

For cracking due to flow-induced vibration of Vermont Yankee's steam dryer, GALL calls for evaluation of the plant-specific aging management program. GALL at IV B1-6. NUREG-1800, Rev 1, "Standard Review Plan for License Renewal Applications for Nuclear Power Plants," ("SRP") (Staff Exh. 19) Section 3.1.2.2.11 "Cracking due to Flow-Induced Vibration" directs the Staff to evaluate plant-specific aging management plans for cracking due to flow-induced vibration in accordance with Branch Technical Position RLSB-1 (Appendix A.1 of the SRP). The Branch Technical Position directs Staff to review the applicant's plan for managing the effects of aging on the steam dryer (cracking due to flow induced vibration) using the same

ten elements described in GALL.⁷ The Staff's review of Entergy's program for managing cracking of the steam dryer due to flow-induced vibrations is documented in the SER (Staff Exh.

1) Sections 3.1.2.1.6 and 3.1.2.2.11.

The Commission also requires, pursuant to 10 C.F.R. § 54.21 "Contents of application—technical information," that license renewal applications contain:

(c) An evaluation of time-limited aging analyses

(1) A list of time-limited aging analyses, as defined in § 54.3, must be provided. The applicant shall demonstrate that—

(i) The analyses remain valid for the period of extended operation

(ii) The analyses have been projected to the end of the period of extended operation; or

(iii) 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). If a licensee chooses to satisfy § 54.21(c)(1)(i) or (ii), the "demonstration" must be in the LRA, and a commitment to perform analyses projecting 60-year CUFs⁸ prior to the period of extended operation is inconsistent with regulatory language.⁹ However, if the

⁷ The ten elements are: scope, preventive actions, parameters to be monitored or inspected, detecting of aging effects, monitoring and trending, acceptance criteria, corrective actions, conformation process, administrative controls, and operating experience.

⁸ It should be noted that the ASME Code does not require that the fatigue analysis include a correction to account for the effects of the reactor water environment, i.e. Fen. Nor do the Commission's regulations require CUFens be less than 1.0. SRP (Staff Exh. 19) Section 4.3.

⁹ Based on a summary of an August 17, 2007 teleconference between the Staff and Entergy, NEC asserts that the Staff's position is that to satisfy § 54.21(c)(1), Entergy must demonstrate in its LRA that its environmentally-assist fatigue analyses are completed. NEC's reliance on this teleconference summary as the basis for the NRC's interpretation of a rule is misplaced. The Staff does not establish agency policies or positions (including interpretations of regulations) via teleconferences nor does it have the authority to do so. Furthermore, contrary to NEC's assertion there is no inconsistency between the Staff's statement on August 17, 2008, and the proposed license condition requiring Entergy to perform ASME Code analyses for the core spray and reactor recirculation nozzles. SER (Staff Exh. 1)Section 1.7. As discussed below, Entergy amended its application on September 17, 2007, to make clear that it intended to satisfy the requirements of 10 C.F.R. § 54.21(c)(1)(iii), not § 54.21(c)(1)(ii), which does requires that the applicant demonstrate an adequate aging management program in its LRA, not that its application 60-year CUFs will not exceed 1.0.

licensee chooses to satisfy § 54.21(c)(iii), the licensee must instead demonstrate that effects of aging *will* be adequately managed and a commitment to perform refined CUF analyses in the future as part of an aging management program is acceptable. One way for a licensee to make the demonstration required by § 54.21(c)(1)(iii) is to commit to follow the guidance provided by GALL in Section X.M1 “Metal Fatigue of Reactor Coolant Pressure Boundary” (Staff Exh. 7) Section X.M1 provides guidance on each of the ten elements¹⁰ of an adequate aging management program. For corrective actions, Section X.M1 recommends that a licensee include one or more of the following to prevent component cumulative usage factors from exceeding the design code limit during the period of extended operation: repair of components, replacement of components, and “more rigorous analysis” of the components. See GALL Section X.M1 (Staff Exh. 7). SRP (Staff Exh. 19) Section 4.3 recommends that license renewal applicants address the effects of the coolant environment on component fatigue life as aging management programs are formulated in support of license renewal. One acceptable way for a licensee to address this recommendation is to assess the impact of the reactor coolant environment on a sample of critical components listed in NUREG/CR-6260.

In its LRA, Entergy stated that for each location that may exceed a CUF of 1.0, it will implement one 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 environmental-assisted fatigue during the period of extended operation, details of the aging management program such

¹⁰ See *supra* note 7.

as scope, qualification, method, and frequency will be provided to the NRC prior to the period of extended operation.

LRA Section 4.3.3. On July 6, 2006, Entergy provided Commitment 27, which it committed to perform a fatigue analysis that addresses the effects of the reactor coolant environment on fatigue at least two years prior to the period of extended operation and, if it choose to manage environmentally assisted fatigue, during the period of extended operations, it would provide the details of that program to the NRC prior to the period of extended operation. SER (Staff Exh. 1 at 4-34) On July 3, 2007, Entergy revised Commitment 27 to specify that it planned to refine its fatigue analyses to lower the predicted CUFs to less than 1.0 at least two years prior to the period of extended operations. *Id.* at 4-35.

On September 17, 2007, Entergy submitted Amendment 31 to its LRA (Staff Exh. 22). This Amendment added the results of the refined fatigue analyses performed for all nine locations identified in NUREG/CR-6260 and removed the exceptions Entergy had previously taken to the guidance in GALL Section X.M1, thus making Entergy's fatigue monitoring program consistent with GALL. Accordingly, in its SER, the Staff reviewed whether Entergy's LRA demonstrated, as required by 10 C.F.R. § 54.21(c)(1)(iii), that its fatigue monitoring program will adequately manage the effects of aging during the period of extended operation. See Staff Exh. 22; SER (Staff Exh. 1) Sections 3.0.3.2.10; 4.3.3.3.

II. Staff's Witnesses

The attached testimony presents the opinions of a panel of five witnesses as follows: Kenneth C. Chang, John R. Fair, Kaihwa R. Hsu, Jonathan G. Rowley, and Thomas G. Scrabrough.

Dr. Chang is the Chief of Engineering Branch 1 in the Division of License Renewal of the Office of Nuclear Reactor Regulation ("NRR"). Statement of Professional Qualifications of Kenneth C. Chang (Staff Exh. 2). Dr. Chang has over 38 years of design, analysis and

qualification experience in the commercial nuclear power industry. *Id.* Prior to joining the NRC in 2002, Dr. Chang worked for Westinghouse Electric Corporation for 21 years and worked as an engineering consultant for various utilities. *Id.* While at Westinghouse, Dr. Chang was the manager for the Reactor Coolant System Analysis Group, and the manager for Piping Systems Engineering Section. *Id.* In his current position at the NRC, Dr. Chang has overall responsibility, in the areas of mechanical and materials engineering, for the safety review of aging management programs (“AMPs”), aging management reviews (“AMRs”), and time-limited aging analysis (“TLAA”), including the metal fatigue to address the environmentally assisted fatigue, associated with the license renewal applications. NRC Staff Affidavit of Kenneth C. Chang Concerning NEC Contentions 2A & 2B (Metal Fatigue) (Staff Exhibit 2). Because he is a known expert in areas of metal fatigue and fatigue monitoring, Dr. Chang personally reviewed Entergy’s metal fatigue submissions and wrote Section 4.3.3 of the SER. *Id.*

Mr. Hsu is currently a senior mechanical engineer in the Division of Engineering in the Office of New Reactors (“NRO”). Statement of Professional Qualifications of Kaihwa R. Hsu (Staff Exh. 3). Previously, he was a materials engineer in NRR’s Division of License Renewal. *Id.* Mr. Hsu has 27 years of experience in the nuclear industry, including significant experience with FAC-predictive codes through his work for the NRC and Westinghouse, where he was part of the team that developed a computer code, the Westinghouse Corrosion-Erosion Monitoring System, which, like CHECWORKS, predicts pipe thinning due to flow-accelerated corrosion (“FAC”). *Id.* As part of his official duties, Mr. Hsu served as a technical lead for the license renewal safety audit at Vermont Yankee. NRC Staff Affidavit of Kiahwa R. Hsu, and Jonathan G. Rowley Concerning NEC Contention 4 (Staff Exh. 4). Mr. Hsu reviewed Entergy’s flow-accelerated corrosion program. *Id.*

Mr. Fair has over 35 years experience in the nuclear power industry, including 31 years at the Nuclear Regulatory Commission. Statement of Profession Qualification of John R. Fair

(Staff Exh. 3). During his career at the NRC, Mr. Fair has acquired significant experience developing staff technical position regarding fatigue evaluation of ASME Code components. *Id.* He has served as a member of ASME Code working groups on seismic design environmental fatigue. *Id.* He has significant experience reviewing topics related to the mechanical design of ASME Code components and fatigue TLAA evaluations for license renewal applications. *Id.* Mr. Fair also has significant experience with design analysis of ASME Code and ANSI B31.1 piping systems. *Id.* In connection with Entergy's LRA for Vermont Yankee, Mr. Fair has advised his colleagues in the Division of License Renewal on Entergy's metal fatigue submissions and supported them at meetings with Entergy and the Advisory Committee on Reactor Safeguards ("ACRS"). NRC Staff Affidavit of John R. Fair Concerning NEC Contentions 2A & 2B (Metal Fatigue) (Staff Exh. 3). Mr. Fair was involved in preparation of "Regulatory Issue Summary 2008-10 Fatigue Analysis of Nuclear Power Plant Components" dated April 11, 2008. *Id.*

Mr. Rowley has over fourteen years of experience in materials science and engineering. Statement of Professional Qualifications of Jonathan G. Rowley ("Rowley Quals.") (Staff Exh. 4). Mr. Rowley has been responsible for coordinating the Staff's review of Entergy's LRA and the Staff's preparation of "Safety Evaluation Report with Confirmatory Items Related to the License Renewal of Vermont Yankee Nuclear Power Station," dated March 2007 (ML070870378) and the SER (Staff Exh. 1). NRC Staff Affidavit of Kaihwa R. Hsu, Jonathan G. Rowley, and Thomas G. Scarbrough Concerning NEC Contention 3 (Steam Dryer) (Staff Exh. 4). In addition to his involvement the Staff's review of Entergy's LRA, Mr. Rowley was involved in the Staff's review of the license renewal applications for the D.C. Cook and R.E. Ginna plants. Rowley Quals (Staff Exhibit 4).

Mr. Scarbrough has 30 years of experience of technical experience in the field of nuclear engineering. Statement of Professional Qualifications of Thomas G. Scarbrough (Staff Exh. 4).

In the course of his career he served as Special Technical Advisor to the Atomic Safety and Licensing Appeal Panel (ASLAP) for the restart of the Three Mile Island (TMI) Unit 1 nuclear power plant and, later, was appointed as Technical Advisor to the ASLAP. *Id.* Working in the Mechanical Engineering Branch of NRR, Mr. Scarbrough was the principal engineer for the NRC staff review of the implementation of Generic Letter (GL) 89-10, "A Safety-Related Motor-Operated Valve Testing and Surveillance." *Id.* Following the failure of the steam dryer at Quad Cities Unit 2 in 2002, Mr. Scarbrough participated in the Staff's review of potential adverse flow effects on plant components during power uprate operation. *Id.* He worked on the power uprate license amendments for Vermont Yankee, Browns Ferry, Hope Creek, and Susquehanna. *Id.* Since February 2007, Mr. Scarbrough has worked in the Component Integrity, Performance, and Testing Branch II in NRO where he reviews component issues for proposed new reactors, and provides assistance to NRR on potential adverse flow effects for power uprates at operating nuclear power plants. *Id.*

III. The Concerns Raised by NEC's Contentions Lack Merit

The Staff's testimony presents its position that the concerns raised by NEC's contentions lack merit because Entergy's programs for managing effects of metal fatigue, the aging of the steam dryer, and flow-accelerated corrosion of reactor coolant pressure boundary piping are adequate to manage the effects of aging so that the intended functions will be maintained consistent with the CLB for the period of extended operation. The bases for this position are described in detail in the testimony.

A. NEC 2A & 2B (Recalculation of CUFs)

NEC's Contentions 2A and 2B question the validity of Entergy's TLAA assessment of the impact of environmentally-assisted fatigue on key components during the period of extended operation. NEC Initial Position at 3. The Staff's position is that Entergy's Fatigue Monitoring Program ("FMP") is adequate to manage aging due to metal fatigue as required by 10 C.F.R.

§ 54.21(c)(a)(3) and Entergy's FMP is consistent with the program described in GALL Section X.M.1 and, satisfies the requirements of 10 C.F.R. § 54.21(c)(1)(iii). SER Section 3.0.3.2.10 at 3-75; Section 4.3.3.4 at 4-43; Staff Exh. 2 at A29. An element of the FMP is to take corrective actions if CUF values approach the allowable limit. GALL Section X.M.1; Staff Exh. 2 at A29. As a corrective action, in September 2007, Entergy performed a refined analysis of the CUFen of all nine locations listed in NUREG/CR-6260. The Staff, however, could not confirm the validity of the refined analysis because the analysis was performed using a simplified method that combines six stress components into one. SER (Staff Exh 1) Section 4.3.3.2 at 4-38; Staff Exh. 2 at A4. Therefore, the Staff asked Entergy to provide additional information and analysis. SER (Staff Exh. 1). at 4-39 to 4-40; Staff Exh. 2 at A4. In January 2008, Entergy submitted a "Confirmatory Analysis" for the feedwater nozzle to demonstrate that the results submitted in September 2007 were conservative. SER (Staff Exh. 1). at 4-41. This analysis was performed in accordance with ASME Code Section III, Subsection NB-3200. SER (Staff Exh. 1) at 4-43. The Staff requested that Entergy perform the "Confirmatory Analysis" for the feedwater nozzle because it is the nozzle with the highest stresses. *Id.* at 4-40; Staff Exh 2 at A4. The Staff confirmed that geometry of the feedwater nozzle bounds the geometry of the recirculation nozzle through its review of Entergy's February 5, 2008 to two Staff RAIs. SER (Staff Exh. 1) at 4-41; Staff Exh. 2 at A23.

Although the "Confirmatory Analysis" was acceptable to the Staff, and the CUF for the feedwater nozzle was less than 1.0, the CUF produced by the "Confirmatory Analysis" was greater than that produced by the September 2007 analysis and thus not bounding. SER (Staff Exh. 1). at 4-42 to 4-43; Staff Exh. 2 at A20. Therefore, the Staff requested that Entergy make the "Confirmatory Analysis" the analysis of record for the feedwater nozzle. SER (Staff Exh. 1) at 4-42; Staff Exh. 2 at A4. Also, because the September 2007 analysis was not bounding for the feedwater nozzle, the Staff proposed a license condition requiring that Entergy perform

ASME Code analyses for the core spray and reactor recirculation outlet nozzle at least two years prior to the period of extended operation and make those analyses the analyses of record for the core spray and reactor recirculation outlet nozzles. SER (Staff Exh. 1) at 4-42; Staff Exh. 2 at A4, A20. Although the Staff has imposed this license condition, the Staff is confident ASME Code analyses of the core spray and reactor recirculation outlet nozzles will be below the allowable limit. SER (Staff Exh. 1) at 4-42; Staff Exh. 2 at A20, A26.

The Staff disagrees with NEC's assertion that Entergy should have used the Fen values in NUREG/CF-6909 instead of the "outdated" statistical equations in NUREG/CR 6583 and NUREG/CR 5704) to perform its analysis. Staff Exh. 2 at A17; A18; Staff Exh. 3 at A5. NUREG/CG-6909 does not apply to the existing fleet of commercial nuclear power plants. *Id.* The Staff also disagrees with NEC's assertion that Entergy did not calculate Fens properly. Staff Exh. 2 at A14. Through Entergy's February 5, 2008 response to a Staff RAI about the effects of water chemistry and its February 14, 2008 Audit, the Staff confirmed that Entergy properly considered dissolved oxygen (which will be managed by Vermont Yankee Water Chemistry Program during the period of extended operation), strain rate, temperature and sulfur content in calculating Fens. SER (Staff Exh. 1) Section 4.3.3.2 at 4-41 to 4-42; Staff Exh. 2 at A15. The Staff also verified that values of strain rate, temperature, and sulfur content used in the calculation of Fen would remain valid for the period of extended operations. SER (Staff Exh. 1) at 4-42; Staff Exh. 2 at A15.

The Staff also disagrees with NEC's assertion that Entergy's assumptions about the number of transients in its analyses are not conservative. The Staff's position is that Entergy's assumptions are appropriate and that the actual number of transients will be tracking by Entergy's FMP, which will ensure that the predicted number of transients is not exceeded. SER (Staff Exh. 1) Section 3.0.3.2.10; Staff Exh. 2 at A10; A26-28.

Furthermore, the Staff disagrees with Dr. Hopenfeld's CUFen calculations. Exhibit

NEC_JH-3 at 20. Dr. Hopenfeld's calculations are based on LRA Table 4-3-1 and 4.3-3. Staff Exh. 2 at A12. During an audit, the Staff determined that the CUF values in those tables were not Vermont Yankee-specific CUFs, but rather were representative values taken directly from NUREG/CR-6260. SER Section 4.3.3.2 at 4-34. Dr. Hopenfeld also used maximum Fen values for low-alloy steel and stainless steel. In so doing he assumed the worst-case scenarios for reactor conditions. Staff Exh. 2 at A12. Dr. Hopenfeld selected environmental correction factors of 17 for carbon and low alloy steels and 12 for stainless steel without considering the entire fatigue evaluation procedure in NUREG/CR-6909. Staff Exh. 3 at A6. Entergy, however, has proven based on data collected over Vermont Yankee's operating history that using the worst-case numbers is not appropriate. Staff Exh. 2 at A12.

B. NEC 3 (Steam Dryer)

The Staff's position is that Entergy's program for managing the effects of age on Vermont Yankee's steam dryer, the Steam Dryer Monitoring Program ("SDMP") is adequate to maintain the structural integrity of the steam dryer during the period of extended operation. Staff Exh. 4 at A17. Vermont Yankee's SDMP includes periodic monitoring plant parameters that may be affected by steam dryer structural integrity and periodic visual inspections. *Id.* Monitoring of these plant parameters is adequate to detect significant degradation during operation. *Id.* A10.

The Staff disagrees with NEC's assertion that an adequate steam dryer aging management program must include some means of estimating and predicting stress loads on the dryer during operation to ensure that established fatigue limits are not exceeded. *Id.* A14-A16. The Staff's position is that continuous stress analysis of the Vermont Yankee steam dryer (i.e. a means of estimating and predicting stress loads during operations) is not necessary because the results of the EPU power ascension program demonstrated that the pressure loads during EPU operation do not result in stress on the steam dryer that exceeds the ASME fatigue

stress limits. *Id.* at A16. In addition, the result of the 2007 steam dryer inspection demonstrated that no significant fatigue cracking occurred during EPU operation. *Id.* at A17.

Based on the recent EPU power ascension data and the 2007 steam dryer inspection, the Staff's position is that monitoring of plant parameters and periodic steam dryer inspections are sufficient to provide reasonable assurance in the structural capability of the Vermont Yankee steam dryer over the long term. *Id.*

C. NEC 4 (Flow-Accelerated Corrosion)

The Board has found that Contention 4 presents a classic battle of the experts, with Entergy's experts asserting that extensive benchmarking is not necessary and the data from the three refueling outages at EPU prior to license renewal is sufficient and NEC's expert asserting that 10-15 years of data are needed. August 10 Order at 2, 7. The Staff's position is that two cycles of inspection data are usually needed to recalibrate CHECWORKS following a change in plant parameters. Staff Exh. 5 at A19, 20, 27. However, in the case of Vermont Yankee, only one cycle of inspection is needed because, as confirmed by inspection conducted during the 2007 outage, increases in velocities in the main steam line and feedwater lines from the EPU caused proportional increases in FAC wear rates. *Id.* A20. While only one cycle of inspection is necessary to recalibrate CHECWORKS to EPU conditions at Vermont Yankee, Entergy will have performed three inspections prior to the period of extended operation and inspections will continue throughout the life of the plant. *Id.*

Corrosion is not an exact science. Due to epistemic and aleatory uncertainty, absolute wear rates cannot be determined no matter how many inspections are performed. *Id.* at A12. CHECWORKS is a tool to help identify which FAC-susceptible piping, monitor FAC, and mitigate FAC in advance of failure. *Id.* at A25. Entergy is not relying solely on CHECWORKS to select locations for inspection. *Id.* at A35. Entergy also considers components identified in previous inspections, industry experience, susceptible piping not modeled by CHECWORKS,

plant specific experience, and engineering judgment. *Id.*

The Staff disagrees with NEC's assertion that 10-15 years of trending is necessary. *Id.* at A19, A21. The Staff reviewed the pages from an industry guidance document cited by NEC in support of its assertion. Chokie Group International, "Aging Management and Life Extension in the US Nuclear Industry" (October 2006) (Exhibit NEC_UW-13 at 38). According to the passage referenced by NEC, the 5-10 year recommendation is not for trending or preventive maintenance programs, but for trending the number of work orders for major equipment maintenance over 10-15 years. *Id.* at A19. The document does not suggest that 5-10 years of FAC data is needed. *Id.*

The Staff also disagrees with NEC's assertion that Entergy cannot use CHECWORKS because of its 20% EPU. *Id.* A21-A23. Plants similar to Vermont Yankee have approved EPUs and are successfully using CHECWORKS. *Id.* at A21, A23-A24. The original power levels for all of those plants were much greater than Vermont Yankee's and therefore their MWt. increases in output are greater. *Id.* at A23.

In sum, the Staff's position is that Entergy's program for monitoring FAC at Vermont Yankee is adequate because the program is consistent with the GALL Report's recommendations in Section X1.M17, Entergy has committed to perform an operating experience review and its impact on aging management programs (which addresses the Staff's concerns for license renewal applications with approved EPUs), and Entergy's detailed discussion of FAC in BVY-04-008, which demonstrates that Entergy has adequately addressed the impact of the EPU on FAC-susceptible locations. *Id.* at A39. SER (Staff Exh. 1) at Section 3.0.3.1.2. Entergy has thus demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the current licensing basis for the period of extended operation. Staff Exh. 5 at A39.

CONCLUSION

For the reasons discussed above, NEC Contentions 2A, 2B, 3, and 4 should be resolved
in favor of Entergy

Respectfully submitted,

/RA/

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/RA/

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Dated at Rockville, Maryland
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