

May 17, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)	
)	
ENTERGY NUCLEAR VERMONT YANKEE,)	Docket No. 50-271-OLA
LLC and ENTERGY NUCLEAR)	
OPERATIONS, INC.)	ASLBP No. 04-832-02-OLA
)	
(Vermont Yankee Nuclear Power Station))	

NRC STAFF'S INITIAL STATEMENT OF POSITION
CONCERNING NEC CONTENTION 4

The NRC Staff ("Staff") submits this "Initial Statement of Position" pursuant to 10 C.F.R. § 2.1207(a)(1) and the Atomic Safety and Licensing Board's "Revised Scheduling Order" ("Scheduling Order") dated April 13, 2006, at 3. The Staff is filing, simultaneously herewith, the "NRC Staff Testimony of David C. Jeng, Steven R. Jones and Richard B. Ennis Concerning NEC Contention 4" ("Seismic Testimony"). For the reasons set forth herein and in the Staff's Seismic Testimony filed herewith, the Staff submits that a careful evaluation of New England Coalition ("NEC") Contention 4 demonstrates that this contention is wholly lacking in merit. Accordingly, the Staff submits that NEC Contention 4 should be resolved in favor of issuance of the extended power uprate ("EPU") license amendment requested by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (collectively referred to herein as "Entergy" or "Applicant") for the Vermont Yankee Nuclear Power Station ("Vermont Yankee").

INTRODUCTION

This proceeding concerns the application filed by Entergy for an amendment to the Vermont Yankee operating license, to authorize an increase in the maximum power level by approximately 20%. Petitions for leave to intervene and contentions were then filed by the

State of Vermont Department of Public Service and NEC. Among the contentions filed by NEC was its original Contention 4.¹ On November 22, 2004, the Licensing Board admitted NEC Contention 4, which, as admitted and restated by the Licensing Board, stated as follows:

The license amendment should not be approved because Entergy cannot assure seismic and structural integrity of the cooling towers under uprate conditions, in particular the Alternate Cooling System cell. At present the minimum appropriate structural analyses have apparently not been done.

Entergy Nuclear Vermont Yankee, L.L.C., and Entergy Nuclear Operations, Inc. (Vermont Yankee Nuclear Power Station), LBP-04-28, 60 NRC 548, 580 (2004). In admitting the contention, the Licensing Board stated, "The gist of this contention is that a new seismic and structural analysis should be performed to qualify the Vermont Entergy cooling towers for the additional loads that will result from increasing the maximum power by 20%." *Id.* at 573; emphasis added.

On May 25, 2005, Entergy submitted a cooling tower seismic evaluation,² and on July 13, 2005, it filed a motion to dismiss NEC Contention 4 as moot, or in the alternative, for summary disposition of the contention, based on its submission of that analysis.³ In a Memorandum and Order dated September 1, 2005, the Licensing Board granted the Applicant's motion to dismiss the contention as moot, finding that the Applicant's submittal of its seismic

¹ "New England Coalition's Request for Hearing, Demonstration of Standing, Discussion of Scope of Proceeding and Contentions," dated August 30, 2004, at 11-12; emphasis added. The basis for this contention was identified as "the Declaration of Arnold Gundersen under Ultimate Heat Sink [Exhibit D] and further testimony to be provided at hearing . . ." *Id.* at 12; *see also* "Declaration of Arnold Gundersen in Support of Petitioners' Contentions," dated August 30, 2004, at 5-7.

² See Calculation No. 1356711-C-001, "Cooling Tower Seismic Evaluation," dated April 5, 2005, prepared by ABS Consulting ("ABS") on behalf of Entergy.

³ See "Entergy's Motion to Dismiss as Moot, or in the Alternative, for Summary Disposition of New England Coalition Contention 4," dated July 13, 2005. *See also* (1) "NRC Staff's Answer to Entergy's Motion to Dismiss as Moot, or in the Alternative, for Summary Disposition of [NEC] Contention 4," dated July 25, 2005; and (2) "New England Coalition's Answer Opposing Entergy's Motion to Dismiss as Moot, or in the Alternative, for Summary Disposition of [NEC's] Contention 4" dated August 2, 2005.

analysis satisfied the contention's assertion that such an analysis had not been submitted.

Entergy Nuclear Vermont Yankee, L.L.C., and Entergy Nuclear Operations, Inc. (Vermont Yankee Nuclear Power Station), LBP-05-24, 62 NRC 429, 434 (2005). At the same time, the Board afforded NEC an opportunity to file a new contention challenging the adequacy of that analysis, ruling that "[t]o the extent that NEC has specific complaints regarding Entergy's new seismic and structural analysis that are within the scope of the EPU application," NEC may file new or amended contentions. *Id.* at 433.

NEC filed its request for leave to file a new contention on September 21, 2005.⁴ NEC's new contention asserted as follows:

The Entergy Vermont Yankee [ENVY] license application (including all supplements) for an extended power uprate of 20% over rated capacity is not in conformance with the plant specific original licensing basis and/or 10 CFR Part 50, Appendix S, paragraph I(a), and/or 10 CFR Part 100, Appendix A, because it does not provide analyses that are adequate, accurate, and complete in all material respects to demonstrate that the Vermont Yankee Nuclear Power Station Alternate Cooling System [ACS]¹ in entirety, in its current actual physical condition (or in the actual physical condition ENVY will effectuate prior to commencing operation at EPU), will be able to withstand the effects of an earthquake and other natural phenomena without loss of capability to perform its safety functions.² ENVY must be able to demonstrate that the actual structures, systems and components comprising the ACS will perform satisfactorily at the requested increased plant power level.

¹ The ACS system includes, but is not limited to, towers, fill, structural members and bracing, shear pins and/or tie rods, basins, piping, pumps, valves and controls, fan motors, fan decks and fan gearing, emergency electrical supply, and all components vital to design basis objectives and licensing basis requirements intended to assure operability when the system is called upon in an emergency.

² Under uprate conditions, in particular, the removal of additional decay heat generated by uprated reactor power, any seismically induced impairment of the ACS function is apt to eliminate already attenuated margins.

⁴ "New England Coalition's Request for Leave to File A New Contention" ("NEC Request"), dated September 21, 2005.

Request at 1.⁵ On December 2, 2005, the Licensing Board issued a Memorandum and Order admitting NEC's new contention.⁶ Therein, the Board found, inter alia, that the contention "challenges the sufficiency of the ABS Report." LBP-05-32, 62 NRC at 820. With respect to the scope of the contention, the Board found that the contention was admissible, based on its challenge to the adequacy of the ABS Report. The Board stated, "NEC provides four bases and various supporting evidence, including seven specific examples from the Declaration of Dr. Landsman identifying specific deficiencies in the ABS Report, [NEC Request] at 2-6, and these define the basic scope of the proposed contention." *Id.* at 823. In a subsequent ruling, the Licensing Board confirmed that "the factual scope of NEC Contention 4 is limited to the seven areas where NEC's expert, Dr. Landsman, alleges that the analysis of the seismic and structural condition of the two safety-related cooling tower cells (CT2-1 and CT2-2) contained in the ABS Report, is 'grossly deficient.'" ⁷

The NRC Staff has carefully considered each of the seven areas of deficiency alleged by NEC's expert, Dr. Landsman, in support of this contention. The Staff's detailed evaluation of those matters is set forth, *seriatim*, in the Staff's Seismic Testimony attached hereto. For the reasons set forth therein, as summarized below, the Staff submits that those allegations are entirely lacking in merit.

⁵ NEC provided four bases in support of its contention, along with certain "Supporting Evidence," including a declaration from Dr. Ross B. Landsman. See NEC Request at 4-13 and "Declaration of Dr. Ross B. Landsman Supporting New England Coalition's Alternate Cooling System Contention," dated September 19, 2005 ("Landsman Declaration").

⁶ *Entergy Nuclear Vermont Yankee, L.L.C., and Entergy Nuclear Operations, Inc.* (Vermont Yankee Nuclear Power Station), LBP-05-32, 62 NRC 813 (Dec. 2, 2005).

⁷ *Entergy Nuclear Vermont Yankee, L.L.C., and Entergy Nuclear Operations, Inc.* (Vermont Yankee Nuclear Power Station), "Memorandum and Order (Clarifying the Factual Scope of NEC Contention 4 and Denying Untimely Motion for Enlargement of Time to File Reply Brief" (March 24, 2006) (unpublished), slip op. at 6.

DISCUSSION

A. Legal and Regulatory Requirements

The Commission's requirements pertaining to the structural and seismic adequacy of the Vermont Yankee ACS cooling tower cell are described in the Staff's testimony filed herewith. See Seismic Testimony, at 5-6. Specifically, as set forth in the Staff's Final SE for the Vermont Yankee EPU amendment, the Atomic Energy Commission ("AEC") issued the construction permit for Vermont Yankee on December 11, 1967. A low power operating license for the facility was issued on March 21, 1972, and a full power operating license was issued on February 28, 1973. Final SE § 1.2, at 1.⁸ As stated in the Final SE, "the plant was designed and constructed based on the proposed General Design Criteria (GDC) published by the AEC in the *Federal Register* . . . on July 11, 1967." *Id.* at 1.⁹ The applicability of the Draft GDC to Vermont Yankee was not affected by the AEC's subsequent adoption of 10 C.F.R. Part 50, Appendix A ("General Design Criteria for Nuclear Power Plants") (*i.e.*, the "Final GDC") on February 20, 1971.¹⁰ See Final SE § 1.2, at 1. Finally, the Final SE indicates that the ACS was designed and implemented during "during the original plant licensing." *Id.* at 2.¹¹

⁸ See "Vermont Yankee Nuclear Power Corp., Notice of Issuance of Facility Operating License," 37 Fed. Reg. 6345 (Mar. 28, 1972); "Vermont Yankee Nuclear Power Corp., Notice of Issuance of Amendment to Facility Operating License," 38 Fed. Reg. 6313 (Mar. 8, 1973). The letters of transmittal are available in ADAMS at Accession Nos. ML011620261 and ML011580230.

⁹ Final SE § 1.2 at 1, referring to "Licensing of Production and Utilization Facilities, General Design Criteria for Nuclear Power Plant Construction Permits," 32 Fed. Reg. 10,213 (July 11, 1967).

¹⁰ See "Part 50 – Licensing of Production and Utilization Facilities, General Design Criteria for Nuclear Power Plants," 36 Fed. Reg. 3255 (Feb. 20, 1971).

¹¹ The Final SE further observes that "[t]he ACS is not classified as an engineered safeguards system and is not designed to accept the consequences of a design basis loss-of-coolant accident (LOCA). It is also not designed to meet single failure criteria. . . . The ACS is designed to provide adequate heat removal for these [specified] postulated events to achieve and maintain safe shutdown when the normal SW system (*i.e.*, pumping from the Connecticut River) is lost." Final SE § 1.2, at 2.

The Commission's requirements pertaining to the structural and seismic adequacy of Vermont Yankee's ACS cooling tower cell were established in the facility's original licensing basis, in Draft General Design Criterion 2 ("Draft GDC 2"). Draft GDC 2 provides as follows:

Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation of their consequences shall be designed, fabricated, and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice, and other local site effects. The design bases so established shall reflect:
(a) Appropriate consideration of the most severe of these natural phenomena that have been recorded for the site and the surrounding area and (b) an appropriate margin for withstanding forces greater than those recorded to reflect uncertainties about the historical data and their suitability as a basis for design.¹²

This original licensing basis continues to apply to the Vermont Yankee ACS cooling tower cell and constitutes the regulatory standard against which this structure should be evaluated.¹³

B. Staff Witnesses

In its Seismic Testimony, the Staff presents the opinions of three highly qualified experts, as follows: (1) David C. Jeng, a Senior Structural Engineer in the Division of Engineering, NRC Office of Nuclear Reactor Regulation ("NRR"); (2) Steven R. Jones, a Senior Reactor Systems Engineer in the Division of Systems Safety, NRR; and (3) Richard B. Ennis, a Senior Project Manager in the Division of Operating Reactor Licensing, NRR. In their testimony, the Staff's witnesses describe their current responsibilities, as well as their responsibilities with respect to the Staff's review of the Vermont Yankee EPU application and/or NEC Contention 4. Seismic Testimony at 2-4.

¹² 32 Fed. Reg. at 10,215.

¹³ The Applicant has confirmed that Draft GDC-2 constitutes the applicable regulatory standard for the Vermont Yankee ACS. See Entergy Nuclear Northeast Vermont Yankee, "Design Basis Document for Service Water Systems; Service Water, Residual Heat Removal Service Water, and Alternate Cooling Systems," Document No. SWSYS, Rev. 1 (Feb. 4, 2004), § 2.2.1.1 at 13.

As described in his testimony, Mr. Jeng (a Civil Engineer) is responsible for performing safety reviews of nuclear power plant structures, to ensure that there is reasonable assurance that the structural integrity and the safety functions of those structures are maintained when subject to various combinations of design basis loads including design basis earthquake and accident loads. *Id.* at 2. With respect to his evaluation of the ACS cooling tower issues raised in this contention,¹⁴ Mr. Jeng reviewed each of NEC's assertions, as well as the ABS Report and various other documents, requested and obtained information as necessary. *Id.* at 4, 11.¹⁵ In addition, he visited the Vermont Yankee site and performed a walk-down of Cells CT2-1 and CT2-2 cells of the west cooling tower, and personally examined key structural elements of that structure. *Id.* at 11. As discussed below, Mr. Jeng's testimony provides a detailed assessment of each of the specific deficiencies alleged by NEC's expert, Dr. Landsman as well as a sound refutation of each such alleged deficiency.

As described in his testimony, Mr. Jones (a Mechanical Engineer) is responsible for evaluating the functional requirements, design, and performance of auxiliary, support and balance-of-plant systems (main steam and turbine, feedwater and condensate, diesel generator support, auxiliary feedwater, spent fuel pool cooling, circulating water, open and closed cycle cooling water, and reactor coolant leakage detection systems) for both current and planned nuclear plants. He also evaluates design features and methods for protection of essential systems and components from the effects of internal and external flooding, internally and

¹⁴ Vermont Yankee has two cooling towers (CT1 and CT2), each of which contains 11 cells. The structure and location of the cooling towers are described in the Staff's Seismic Testimony. See Seismic Testimony at 4, and 9-10. As indicated therein, Cell CT2-1, located in the north end of the west cooling tower, is part of the facility's Alternate Cooling System. In the Staff's testimony, unless otherwise indicated, the term "ACS cooling tower" is used to refer to Cell CT2-1, inasmuch as only that cell is part of the Vermont Yankee ACS. Where appropriate, the testimony refers to other cells, including Cell CT2-2, explicitly. *Id.* at 4 n.3.

¹⁵ Dr. Jeng also provided a brief summary of his conclusions regarding this contention in Section 2.5.3.4 ("Ultimate Heat Sink") of the Staff's Final Safety Evaluation ("SE"), issued on March 2, 2006. Seismic Testimony at 4.

externally generated missiles, and postulated pipe breaks outside containment. *Id.* at 2. With respect to the Vermont Yankee EPU application, Mr. Jones supervised the Staff's safety review of balance-of-plant systems, including cooling water systems such as the ACS; those reviews are described in Sections 2.5 and 2.12 of the Staff's Draft and Final Safety Evaluations for the EPU application. *Id.* at 3.¹⁶

As described in his testimony, Mr. Ennis (an Electrical Engineer) serves as the Staff's Project Manager for the Vermont Yankee EPU license amendment. As part of his official responsibilities, Mr. Ennis coordinated the Staff's evaluation of the Vermont Yankee EPU application, assisted in preparation of the Staff's Draft Safety Evaluation for the EPU application, and coordinated the Staff's preparation of the Final SE and the EPU license amendment, which the Staff issued on March 2, 2006. *Id.* at 2, 4.

C. The Concerns Raised in NEC Contention 4 Are Without Merit.

The Staff's testimony presents the Staff's conclusion that the Vermont Yankee ACS cooling tower (cell CT2-1) is in compliance with the applicable regulatory standard, set forth in Draft GDC 2. *Id.* at 6. Further, the Staff's testimony provides the Staff's views with respect to NEC Contention 4, and demonstrates that NEC's concerns regarding the sufficiency of the Applicant's ABS Report vis a vis the seismic and structural capability of the Vermont Yankee ACS cooling tower are without merit. *Id.* at 10-27.

The Factual Issues

As admitted by the Licensing Board, NEC Contention 4 states as follows:

¹⁶ See "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" (March 2, 2006) (ADAMS Accession No. ML060050028) (non-proprietary version). The Staff intends to offer the non-proprietary version of the Final SE into evidence during the hearing, inasmuch as NEC's representative has declined to execute a non-disclosure affidavit as required to obtain proprietary information in the proceeding. The Staff may also offer into evidence a proprietary version of the Final SE, with distribution limited to the Licensing Board and parties entitled to receive proprietary information.

NEC Contention 4

The Entergy Vermont Yankee [ENVY] license application (including all supplements) for an extended power uprate of 20% over rated capacity is not in conformance with the plant specific original licensing basis and/or 10 CFR Part 50, Appendix S, paragraph I(a), and/or 10 CFR Part 100, Appendix A, because it does not provide analyses that are adequate, accurate, and complete in all material respects to demonstrate that the Vermont Yankee Nuclear Power Station Alternate Cooling System [ACS] in its entirety, in its actual physical condition (or in the actual physical condition ENVY will effectuate prior to commencing operation at EPU), will be able to withstand the effects of an earthquake and other natural phenomena without loss of capability to perform its safety functions in service at the requested increased plant power level.

As summarized by the Licensing Board in its Memorandum and Order of March 24, 2006, Dr. Landsman's Declaration in support of this contention alleged that the ABS Report was "grossly deficient" in the following seven respects:

- (1) ABS did not conduct a physical examination of the alternate cooling tower cell;
- (2) ABS's report lacks adequate documentation of the breaking strength of the tie rods;¹
- (3) ABS's report does not use added conservatism in accounting for the effects of aging mechanisms and/or moisture and/or cooling system chemicals;
- (4) ABS's structural analysis fails to assign a negative value to the replacement rate for degraded members;
- (5) ABS's report fails to account for changes to ACS after the report was completed;
- (6) ABS relies on incorrect and non-conservative assumptions concerning the condition of the concrete in the alternate cooling tower cell and fails to take into account the unanalyzed effects of recent modification including steel splices; and
- (7) ABS does not provide reasonable assurance of seismic qualification of the ACS.

¹ The alleged deficiency related to these tie rods, which are part of the interface between the two safety-related ACS cooling tower cells and the

remainder of the cooling system, is also included in the admitted scope of NEC Contention 4.

Memorandum and Order of March 24, 2006, at 7-8.

Description of the ACS and Cooling Towers

The Staff's testimony provides a description of the Alternate Cooling System ("ACS") at Vermont Yankee, and the purpose and function of this system. As indicated therein, the function of the ACS is to provide an alternate means of cooling selected components necessary for safe shutdown in the unlikely event that all of the service water pumps become inoperable. The system is designed to retain its function following design earthquake ground motion. Cooling water is supplied by gravity flow from the cooling tower deep basin to the inlet suction of the residual heat removal ("RHR") service water ("SW") pumps. The RHR SW pumps deliver the cooling water to the RHR heat exchangers, diesel generator heat exchangers, emergency core cooling system pump room coolers, spent fuel pool cooling system heat exchangers, and auxiliary components. After cooling these components, the water is returned to the cooling tower where the water is sprayed in the ACS cell of the cooling tower and latent heat is transferred to the atmosphere. The water that is not lost to drift or evaporation drains back into the deep basin. Seismic Testimony at 8.

During ACS operation, the RHR system removes sensible and decay heat from the reactor and primary containment as necessary for safe shutdown, and the spent fuel pool cooling system removes decay heat from the spent fuel pool as necessary to prevent pool boiling. The diesel generators support operation of the ACS and essential support systems during a loss of normal power coincident with a loss of the Vernon Pond. The cooling tower deep basin is sized for one week of system operation before makeup water is required from off-site sources for the scenario where the Vernon Pond is lost. *Id.* at 8-9.

Vermont Yankee has two mechanical draft-type cooling towers. Each tower has eleven 42-foot high cells in line. The towers are 59 feet, 6 inches wide at the top and 45 feet, 6 inches wide at the bottom. The cooling towers are constructed of treated wood with plastic fill and drift eliminators. The cooling towers are designed to withstand a wind load of 30 pounds per square foot and a snow and ice load of 40 pounds per square foot. Each cooling tower cell uses one fan at the top of the structure to induce air flow up through baffles from vents in the base of the tower. The air flow cools water sprayed into the cells. The cooled water is collected in a reinforced concrete basin, which also supports the tower. The West cooling tower basin, referred to as the deep basin, is approximately 15 feet deep, and is designed to store approximately 1.45 million gallons of water for the ACS cooling water inventory. *Id.* at 9.

The north end cell of the West tower is used for alternate cooling, and it is one of the nine cells located over the deep basin. Water returned after cooling components served by the ACS is sprayed over the fill in this cell and then drains to the deep basin. The ACS is a Seismic Class I system and is designed to remain functional in the event of a maximum hypothetical (0.14g) earthquake. The Applicant's FSAR indicates that the ACS cooling tower cell (*i.e.*, cell CT2-1 of the west cooling tower, CT-2), was seismically analyzed for acceptability under two conditions: (1) that cell CT2-1 would maintain its integrity in the event of an earthquake (*i.e.*, cell CT2-1 was evaluated as a Seismic Class I structure), and (2) that cell CT2-1 would not be damaged by other portions of the cooling tower complex in the event of a design basis earthquake. Cell CT2-2 was evaluated as a Seismic Class I structure to ensure it would maintain its integrity during a design basis earthquake and act as a buffer to protect cell CT2-1.

Id. at 9-10.¹⁷

¹⁷ The Staff's testimony also summarizes the fan and motor modifications that have been made to the cooling towers in connection with the EPU amendment; the modifications involved 21 of the 22 cooling tower cells, but did not involve the ACS cooling tower cell (CT2-1). Seismic Testimony at 10.

Evaluation of Dr. Landsman's Alleged Deficiencies

The Staff's Seismic Testimony describes the Staff's evaluation of each of the seven alleged inadequacies specified by Dr. Landsman, and the bases for its conclusion that those allegations are without merit. Mr. Jeng indicates that based on his evaluation of the ABS Report and other relevant documents, and his walk-down of the Vermont Yankee west cooling tower, he concluded that (a) the Applicant utilized appropriate assumptions, proper dynamic structural modeling, and the Vermont Yankee design basis earthquake input motions; (b) the Applicant made proper use of the response spectrum seismic analysis method and modal response combination method, made proper use of structural damping values, and used pertinent design standards and codes; (c) the Applicant's use of the SAP2000 finite element analysis computer code was acceptable; and (d) the Applicant used a conservative evaluation of input parameters, appropriate load combinations, and an appropriate structural member capacity evaluation. Based on his review, he concluded that the Vermont Yankee ACS cooling tower is in compliance with the facility's original licensing basis, *i.e.*, Draft GDC 2. Further, the safety related portions of cooling tower cells CT2-1 and CT2-2 are seismically adequate for the applied loading conditions, all member interaction ratios are 1.0 or less (meaning that computed member stresses remain within their allowables), all connections have adequate capacity, and base anchorage is also adequate. Accordingly, he concluded that: (1) the ABS Calculation is consistent with Vermont Yankee's original licensing basis, including Draft GDC 2, and (2) there is reasonable assurance that the safety-related portions of Vermont Yankee's west cooling tower will maintain their structural integrity and perform their intended safety functions when subject to Vermont Yankee design basis seismic events. *Id.* at 11-12.

I. Failure to Conduct a Physical Examination of the ACS Tower Cell

NEC's first allegation, that "ABS consultants do not claim to have conducted a physical examination of the alternate cooling tower cell," is not a valid concern. Documentation provided

by Entergy makes it clear that its consultants, Paul Baughman and Richard Augustine of ABS Consulting, did conduct a walk-through inspection of each cell in each cooling tower.

Mr. Baughman's Declaration, filed on October 19, 2005, indicates that they inspected the towers to verify that the arrangement, member sizes, and connections details of the load bearing members were as shown on the drawings; they verified that modeling assumptions were reasonable, and confirmed that the physical condition of the towers matched the calculation's assumptions (for example, they inspected the anchor bolts that secure the tower to the foundation concrete and the concrete in the foundations and confirmed they were in good condition). The walk-through inspection performed by Entergy's consultants was reasonable and adequate both in scope and depth for re-evaluation of safety related plant structures subject to plant modifications. NEC's first alleged deficiency is therefore without factual basis. *Id.* at 12-13. Further, Dr. Landsman's assertion that the ABS report fails to account for fill modifications in its seismic evaluation is not valid, as Section 6.2.1.7 of that report (page 23 of 182) indicates that the current values of cooling tower fill water loadings were used in the seismic analysis. *Id.* at 13.

II. Lack of Adequate Documentation of the Breaking Strength of the Tie Rods

NEC's second allegation, that the ABS report lacks adequate documentation of the breaking strength of the tie rods (which are part of the interface between the two safety-related ACS cooling tower cells and the remainder of the cooling system) is similarly not a valid concern. Entergy's consultant, Mr. Baughman, has explained that the transmittal of earthquake loadings from the Seismic Class II cells to the ACS cooling tower (Cell CT2-1) and the cell adjacent to it (Cell CT2-2) is not possible, because the connections between them will break under seismic forces. The tie rods in question are "breakaway ties" located in cell CT2-3 of the west cooling tower. They are not made out of steel, as alleged by NEC, but are made of wood; further, the breakaway ties are not bolted to the members but are attached to them with nails.

These nailed wood splices are designed to break in a seismic event prior to the failure of Seismic Class II cell CT2-3, thus detaching the Seismic Class I cells (CT2-1 and CT2-2) from the Seismic Class II portions of the cooling tower. Entergy has explained that the ABS Report did not include these breakaway ties as load bearing elements because they have a small load carrying capacity as compared to bolted connections; they will break loose at the onset of a seismic event and will not transmit loadings from Seismic Class II cells to the Seismic Class I cells. *Id.* at 13-14. Mr. Jeng personally conducted a walkdown of these breakaway ties and confirmed that they are made of wood, and are not bolted to the members of CT2-2 cell, but are attached to them with relatively flimsy nails. His inspection findings support Entergy's assertion that these breakaway ties will break loose at low seismic levels and separate the Seismic Class I cells from the Seismic Class II cells prior to failure, and will not transmit loadings of any significance from the Seismic Class II cells to the Seismic Class I cells. The Staff has concluded that Entergy's engineering justifications for not including the breakaway ties in the seismic analysis model are reasonable, are supported by good engineering practices, and are acceptable. It was appropriate to exclude the breakaway ties from the seismic analyses, and that NEC's allegation is without merit. *Id.* at 14-15.

Further, there is no basis for NEC's claim that horizontal forces will be transmitted to the ACS cell "through sixty-inch diameter heavy wall (1.2" thick) header pipe." Entergy's consultant makes clear that the piping is made of sections of fiberglass pipe connected together through bell and spigot joints, and has only a ½-inch wall thickness thus, it is not strong enough to transmit horizontal loads from one cell to another, and the pipe will pull apart during a seismic event at the joints rather than transferring longitudinal loads from one cell to another. The Staff therefore agrees with the Applicant's consultants that it was appropriate not to include in the seismic calculation the transmission of seismic forces to the Seismic Class I cells through the header piping, contrary to NEC's allegation. *Id.* at 15.

III. Absence of Additional Conservatism

NEC's third allegation is that the ABS Report does not indicate that it took into account the actual "as-found" condition of the cooling towers, and failed to use added conservatism in accounting "for the effects of aging and/or moisture and/or cooling system chemicals and/or biotic action on the wooden structural members." This is not a valid concern. The Applicant's consultants, Messrs. Baughman and Augustine of ABS Consulting, performed a walkdown inspection of the ACS, to verify that the arrangement, member sizes, and connections details of the load bearing members were as shown on the drawings. During their inspection, they determined that the structural components of the cooling towers and the accessible portions of the concrete foundations were in acceptable physical condition; they also confirmed that the concrete in the tower foundations showed no signs of degradation, and that the anchor bolts securing the towers to the foundations were in sound condition. Mr. Jeng's observations during his walk-down of the west cooling tower foundation concrete confirmed the Applicant's findings. The Staff has therefore concluded that NEC's allegation lacks factual basis. *Id.* at 15-16.

Further, the Staff's review of the ABS Report found many conservative measures that are consistent with the current licensing basis were incorporated into the analysis. Specifically, the analysis included several conservative steps, such as: (1) compliance with the provisions of the Cooling Tower Institute's ("CTI") "Standard Specifications for the Design of Cooling Towers with Douglas Fir Lumber", CTI Bulletin STD-114 November 1996 ("CTI Bulletin STD- 114"), which provides for reductions in the computed strength of cooling tower members to account for wet conditions and the operating temperatures of the cooling towers; (2) a conservative enveloping evaluation of both the summer and winter conditions occurring simultaneously (*e.g.*, inclusion of maximum snow loads plus maximum summer temperature), (3) conservative inclusion of T-bar fill and water in transit loads; (4) conservative use of a 5% damping value in conjunction with the Vermont Yankee design basis maximum hypothetical earthquake ("MHE");

(5) use of the SAP2000 finite element program, that was verified using accepted quality assurance (“QA”) procedures, and (6) conservative use of an allowable stress increase factor. In summary, the ABS Calculation was performed very conservatively in a manner consistent with the Applicant’s current licensing basis. *Id.* at 16-17.

With respect to the aging of ACS structures, in addition to the conservative design and analysis measures taken, Entergy relies on periodic structural inspection and deficiency correction programs at Vermont Yankee, to ensure that ACS structures are in compliance with their current licensing basis and that they maintain the capability to perform their intended safety functions. Further, there is no factual basis for NEC’s assertion that the ACS cooling tower operates in an adverse chemical environment; the cooling tower operates in a controlled chemical environment, and there is no basis for a concern regarding chemically induced aging degradation. *Id.* at 17.

IV. Failing to Assign a Negative Value to the Replacement Rate for Degraded Members

NEC’s fourth allegation is that the ABS structural analysis is unconservative because it fails to assign a negative value to the replacement rate for degraded members; this is not a valid concern. Neither NRC regulations nor established structural engineering practices require structural engineers to assign a so-called “negative value to the replacement rate” for degraded members. At Vermont Yankee, the issue of structural member degradation in operating nuclear power plants has been adequately addressed via effective implementation of plant-specific structural inspection and deficiency correction programs, in accordance with appropriate QA procedures. Entergy conducts twice-a-year inspections of the cooling towers in accordance with a “Cooling Tower Inspection Guideline” that specifies the items to be inspected. Similar inspections are conducted of the cooling tower deep basin; annual inspections of ACS cooling tower mechanical parts are performed; and planned structural repairs are scheduled and

implemented during each refueling outage. Because of the effective application of these inspection and repair programs, it is reasonable to expect that the ACS cooling tower will maintain its structural integrity and safety functions when subject to design basis events, including the maximum historic earthquake loads. For these and other reasons described in the Staff's Seismic Testimony, NEC's concern is without merit. *Id.* at 18.

NEC's concern that the ABS Report uses an "average" age for structural component members does not affect this conclusion. NEC incorrectly assumed that an "average age of structural components (due to replacement of portions)" was used in the design and analysis process of the cooling tower. The concrete strength used in the ACS concrete basin design was based on the 28-day minimum ultimate compressive strength of 3000 psi, and the allowable load capacity calculations for wood members conservatively accounted for load duration, operating moisture level, operating temperature, member size and unbraced compression lengths in accordance with an experience-based and conservatively established CTI design standards. These values did not reflect an "average age" of component members; rather, consistent with CTI design standards, the structural values used by the Applicant were conservative design values that are adequate to account for normal degradation and aging over time. In addition, the Applicant's structural inspection and deficiency correction programs provide reasonable assurance that any significant degradation that occurs will be identified and corrected. Accordingly, this concern is without merit. *Id.* at 19.

V. *Failure to Account for Changes to the Cooling Towers
after the ABS Study*

NEC's fifth allegation is that the ABS Report fails to account for changes to ACS after the report was completed; this is not a valid concern. In this regard, NEC relies upon two items which had been identified in an NRC Integrated Inspection Report issued on July 20, 2005: (1) Installation of Temporary Splices, and (2) Degradation of Cooling Basin Concrete. These

items were reviewed by the NRC resident inspectors at Vermont Yankee during a routine inspection, were found to lack safety significance and were satisfactorily resolved. *Id.* at 20. First, the temporary splice modification involved installation of a Douglas fir 4"x4" wooden splice onto a diagonal bracing member, rather than a "structural steel" splice as alleged by NEC; and the modification restored the brace to full load carrying capability. The NRC inspection verified that the temporary modification did not affect the system's operability; the NRC inspectors identified no findings of significance in this regard; and the inspection report confirmed that the modification did not impair the safety function of the ACS. *Id.* at 20-21. Second, with respect to degradation of the cooling basin concrete, the NRC inspectors evaluated Entergy's operability determinations regarding various items including "damage to alternate cooling deep basin cement wall." A small section (approximately 30 inches long) of the alternate cooling deep basin cement wall was found to have degraded due to cracking, spalling and loss of concrete material. The degraded portion of the wall was restored by Entergy with concrete of appropriate strength. The NRC inspectors reviewed Entergy's operability determination for this item, and concluded that no finding of significance was identified. *Id.* at 21.

The identification of these items in the Inspection Report does not provide any reason to believe that the ACS cooling tower fails to comply with Vermont Yankee's current licensing basis, and does not indicate any inadequacy in the seismic design and structural integrity of the ACS cooling tower. *Id.* at 21. Moreover, the Applicant's consultants from ABS Consulting determined that the accessible portion of the concrete foundations was in acceptable physical condition, and Mr. Jeng's walkdown of the repaired portion of the concrete foundation found it to be in sound condition. NEC's concern regarding these items is without merit. *Id.* at 22.

VI. *ABS Relies on Incorrect and Non-Conservative Assumptions*

NEC's sixth alleged deficiency is that the ABS Report improperly relies on the assumption that concrete always strengthens with time. This is not a valid concern. It is based on two erroneous assumptions: (1) that the actual condition of the installed concrete in the cooling tower foundations is different from that assumed in the calculation, due to the effects of "age and caustic environment;" and (2) that the tension characteristics of reinforced concrete is relevant to the seismic calculation. In this regard, there is no reason to believe that the cooling towers are exposed to a "caustic" environment; rather, discharges from the Vermont Yankee Circulating Water System is regulated by the State of Vermont Discharge Permit, which imposes strict limits on the pH of the water, and the temperature and chemical composition of the discharge; thus, the actual condition of the concrete in the cooling tower foundations is not different from that assumed in the calculation. *Id.* at 22. NEC's concern regarding aging and its effects on the "tension characteristics" of the reinforced concrete is likewise without merit, in that (a) concrete is used as a compressive stress resisting material, and is seldom used as a tensile stress resisting member, and (b) concrete strength (which normally refers to the 28-day concrete ultimate compressive strength) is generally used in structural calculations to determine the allowable reinforced concrete column compressive load-bearing capacity, anchor bolt load bearing capacity, and the flexural capacities of reinforced concrete beams or slabs. The so-called "tension characteristics" of reinforced concrete is not relevant to the seismic capacity calculation. *Id.* at 23.

NEC's assertion that the ABS report improperly relies on a seismic damping ratio for wooden structures even though "structural steel splices" were implemented is without merit. First, the Applicant's use of a 5% seismic damping value is actually conservative, as NRC practice allows the use of 10 to 15 percent of critical damping in a seismic analysis of bolted

wooden structures that may be subject to Vermont Yankee's MHE level earthquake motions.¹⁸ Therefore, NEC's concern about the damping value used is without merit. *Id.* at 23. Second, as discussed above, the splice material for the splice in question was made of wood, not steel. *See id.* at 20, 24. While the wooden splice pieces were attached to the brace by through-bolting with high strength threaded steel rods, hundreds of steel bolts are already in place as part of the CT2 cooling tower (a bolted wooden structure), and the additional use of six 3/4-inch diameter steel bolts for that splice will have no appreciable impact on the seismic response or the structural capacity of the CT2 cooling tower structure, when compared to the large number of bolts already in place in the cooling tower. Modifications such as the wooden splice addressed in this concern are considered to be a minor repair for such a wooden structure, and are consistent with accepted structural engineering practices; moreover, such a minor modification would not change the seismic response of the CT2-1 cell in any appreciable manner. Accordingly, this concern is without merit. *Id.* at 23-25.

VII. ABS Does Not Provide Reasonable Assurance of Seismic Qualification

NEC's seventh alleged deficiency is that the ABS report fails to provide reasonable assurance that Vermont Yankee's cooling towers would be able to withstand a design basis earthquake under extended power uprate conditions. This stated deficiency appears to be based on NEC's conclusion that the ABS Report does not adequately address the seismic qualification of the ACS cooling tower and that it does not demonstrate the seismic resilience of the "entire" ACS; however, NEC alleges no new facts and apparently draws this conclusion from the previously listed alleged deficiencies. Since those alleged deficiencies are faulty, as discussed above, the conclusions drawn from them by NEC are erroneous. *Id.* at 25-26.

Further, there is no merit in NEC's assertion that the Vermont Yankee design basis

¹⁸ See Newmark, N.M. and W.J. Hall, *Development of Criteria for Seismic Review of Selected Nuclear Power Plants*, NUREG/CR-0098, NRC, Washington, D.C., 1978, at Table 1.

earthquake is non-conservative. The Vermont Yankee design basis earthquake was previously reviewed and approved by the Commission as part of the original Vermont Yankee operating license application process. The selection of a design basis earthquake is based upon tectonic conditions as well as regional and local seismicity, which are not affected by reactor operation under EPU conditions. Accordingly, this allegation does not state a deficiency in the Vermont Yankee EPU application or the ABS Report. *Id.* at 26.

Conclusions Regarding the Adequacy of the ABS Report

The Staff has conducted a detailed review of Dr. Landsman's assertions in support of NEC Contention 4. As part of that review, Staff expert David Jeng (a highly qualified Civil Engineer with extensive experience and expertise in conducting structural and seismic evaluations) reviewed the ABS Report and other relevant documents, and conducted a walk-down of the Vermont Yankee west cooling tower in which he personally observed the condition of the ACS cooling tower and other related structures. Based on this review, the Staff has concluded that the Applicant's seismic and structural analysis of the ACS cooling tower cell, as presented in the ABS Report, meets the specific requirements of draft GDC 2. The Applicant has adopted conservative approaches in the design and analysis process for the ACS cooling tower, and the ABS Calculation embraces numerous specific conservatisms, as described above. *Id.* at 26; see Jeng Professional Qualifications. Further, as stated in Section 2.5.3.4 of the Staff's Final SE, the Applicant's seismic and structural evaluation adequately accounts for the cooling tower modifications which were installed to support the EPU; and there is reasonable assurance that the cooling tower modifications, and operations under EPU conditions, will not adversely affect the ability of the ACS to continue to perform its intended safety function following a design basis seismic event. *Id.* at 27.

For the reasons stated in the Staff's Seismic Testimony, there is reasonable assurance that the Vermont Yankee ACS cooling tower would maintain its structural integrity and the

ability to perform its intended safety functions in the event of a Vermont Yankee design basis seismic event. Further, the ABS Report satisfactorily demonstrates that the ACS cooling tower satisfies Vermont Yankee's current licensing basis. *Id.*

CONCLUSION

For the reasons set forth above, the Staff respectfully submits that NEC Contention 4 is wholly lacking in merit. Accordingly, the contention should be resolved in favor of issuance of the requested EPU license amendment for Vermont Yankee.

Respectfully submitted,

/RA/

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Counsel for NRC Staff

Dated at Rockville, Maryland
this 17th day of May, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
)
ENTERGY NUCLEAR VERMONT YANKEE) Docket No. 50-271-OLA
LLC and ENTERGY NUCLEAR)
OPERATIONS, INC.) ASLBP No. 04-832-02-OLA
)
(Vermont Yankee Nuclear Power Station))

CERTIFICATE OF SERVICE

I hereby certify that copies of (1) "NRC STAFF'S INITIAL STATEMENT OF POSITION CONCERNING NEC CONTENTION 4," and (2) "NRC STAFF TESTIMONY OF DAVID C. JENG, STEVEN R. JONES AND RICHARD B. ENNIS CONCERNING NEC CONTENTION 4," in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class; or as indicated by an asterisk (*), by deposit in the Nuclear Regulatory Commission's internal mail system; and by e-mail as indicated by a double asterisk (**), this 17th day of May, 2006.

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