May 17, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

NRC STAFF TESTIMONY OF DAVID C. JENG, STEVEN R. JONES AND RICHARD B. ENNIS CONCERNING NEC CONTENTION 4

Q1. Please state your names, occupations, and by whom you are employed.

A1(a). My name is David C. Jeng (DCJ).[1] I am employed as a Senior Structural Engineer in the Division of Engineering, Office of Nuclear Reactor Regulation ("NRR"), U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached hereto.

A1(b). My name is Steven R. Jones (SRJ). I am employed as a Senior Reactor Systems Engineer in the Division of Systems Safety, in the NRC Office of Nuclear Reactor Regulation, in Rockville, MD. A statement of my professional qualifications is attached hereto.

A1(c). My name is Richard B. Ennis (RBE). I am employed as a Senior Project Manager in the Division of Operating Reactor Licensing in the NRC Office of Nuclear Reactor Regulation, in Rockville, MD. A statement of my professional qualifications is attached hereto.

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[1] In this testimony, the sponsor of each numbered paragraph is identified by his initials; no such designation is provided for paragraphs that are sponsored by all witnesses.

Q2. Please describe your current responsibilities.

A2(a). (DCJ) I am responsible for performing safety reviews of nuclear power plant structures including containment structures, other structures and structural supports. Other structures include auxiliary buildings, control buildings, fuel handling buildings, emergency diesel generator buildings, spent fuel pools and spent fuel racks, intake structures, ultimate heat sink, miscellaneous structural supports and foundations. The primary objective of my review is to ensure that there is a reasonable assurance that the structural integrity and the safety functions of these structures are maintained when subject to various combinations of design basis loads including design basis earthquake and accident loads.

A2(b). (SRJ) I am 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 cooing, circulating water, open and closed cycle cooling water, and reactor coolant leakage detection systems) for both current and planned nuclear plants. I also evaluate design features and methods for protection of essential systems and components from the effects of internal and external flooding, internally and externally generated missiles, and postulated pipe breaks outside containment. In addition to evaluating licensing actions, I provide technical expertise for inspections, operational event reviews, and policy activities in the assigned areas of review responsibility.

A(2)(c). (RBE) I currently serve as the Project Manager for the NRC Staff (“Staff”), concerning the extended power uprate (“EPU”) license amendment for the Vermont Yankee Nuclear Power Station (“Vermont Yankee” or “VYNPS”). I am currently responsible for NRC headquarters coordination and communication of technical issues related to the Vermont Yankee EPU.

Q3. Please explain what your duties have been in connection with the NRC Staff's review of the application of Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear operations, Inc. (collectively, "Entergy" or "Applicant") for an extended power uprate ("EPU") license amendment for the Vermont Yankee Nuclear Power Station ("Vermont Yankee" or "VYNPS").

A3(a). (SRJ) As part of my official responsibilities, I supervised the Staff's safety review of mechanical systems other than those directly associated with the nuclear steam supply system (*i.e.*, "Balance-of-Plant" systems) related to the Vermont Yankee EPU application; these include cooling water systems such as the alternate cooling system ("ACS"). My supervisory role included verifying that the Staff developed safety conclusions which are adequately supported by the Applicant's responses to Staff requests for additional information and the Staff's technical evaluation of the effects of the proposed EPU on Balance-of-Plant systems. These technical reviews are described in Sections 2.5 and 2.12 of the Staff's draft Safety Evaluation for the EPU application ("Draft SE"), issued to the Advisory Committee on Reactor Safeguards ("ACRS") in October 2005 (Revision 0), and to the public in November 2005 (Revision 1) (ADAMS Accession No. ML0530101670); and in the Staff's Final Safety Evaluation for the EPU application ("Final SE"), issued on March 2, 2006.[2] As part of my responsibilities, I reviewed applicable portions of the Applicant's Final Safety Analysis Report ("FSAR"), the Staff's proposed requests for additional information ("RAIs") related to the ultimate heat sink, and the Applicant's responses to the RAIs. In addition, I reviewed and approved Section 2.5.3.4 of the Draft SE.

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[2] *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" (Mar. 2, 2006) (ADAMS Accession No. ML060050028) (non-proprietary version).

A3(b). (DCJ) As part of my official responsibilities, I reviewed New England Coalition ("NEC") Contention 4, in which NEC challenges the adequacy and completeness of the Applicant's ABS Report concerning the seismic and structural capability of the Vermont Yankee ACS cooling tower.[3] In this regard, I reviewed the ABS Report and various other documents described in response to Question 13 below, requested and obtained information as necessary concerning the matters alleged in the contention, and provided a summary of my conclusions regarding the contention in Section 2.5.3.4 ("Ultimate Heat Sink") of the Staff's Final Safety Evaluation ("SE"), issued on March 2, 2006.

A(3)(c). (RBE) As part of my official responsibilities as the Senior Project Manager for the Staff's review of the Vermont Yankee EPU, I have served as the principal point of contact in NRR for activities related to the Vermont Yankee EPU application. In addition, I coordinated the Staff's evaluation of the Vermont Yankee EPU application, and assisted in preparation of the Staff's draft "Safety Evaluation" for the EPU application ("Draft SE"); and I coordinated the Staff's preparation of the Final SE and the EPU license amendment, which the Staff issued on March 2, 2006.

Q4. What is the purpose of this testimony?

A4. The purpose of this testimony is to provide the NRC Staff's views with respect to NEC Contention 4, challenging the sufficiency of the Applicant's ABS Report concerning the seismic and structural capability of the Vermont Yankee ACS cooling tower.

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[3] As described in response to Question 10 below, Vermont Yankee has two cooling towers (CT1 and CT2), each of which contains 11 cells. Each cell consists of a structure made of treated wood and other components. Cell CT2-1, located in the north end of the west cooling tower, is part of the facility's Alternate Cooling System. The ACS and the ACS cooling tower are described *infra,* in response to Question 10. In this 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.

Q5. Please identify the Commission's requirements pertaining to the structural and seismic adequacy of the Vermont Yankee ACS cooling tower cell, which you considered in your evaluation of this matter.

A5. (RBE) 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 the Vermont Yankee Nuclear Power Station 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.[4] 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.[5] The Final SE notes that 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.[6] *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.[7]

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[4] *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.

[5] 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).

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

[7] 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.[8]

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.[9]

Q6. Has the Staff reached a conclusion as to whether the Vermont Yankee ACS cooling tower (cell CT2-1) is in compliance with the applicable regulatory standard?

A6. (DCJ, RBE) Yes. The Staff has concluded that the Vermont Yankee ACS cooling tower (cell CT2-1) complies with the applicable regulatory standard, set forth in Draft GDC 2.

Q7. Are you familiar with NEC Contention 4?

A7. Yes. As admitted by the Licensing Board, NEC Contention 4, states as follows:

> **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

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[8] 32 Fed. Reg. at 10,215.

[9] 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.

> 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.

Further, we have reviewed the Licensing Board's Memorandum and Order of March 24, 2006, in which it clarified that the factual scope of this contention is limited to the seven specific deficiencies alleged by NEC consultant Dr. Ross B. Landsman in his Declaration of September 19, 2005, with respect to the adequacy of the Applicant's ABS Report concerning the ACS cooling tower cell. Memorandum and Order of March 24, 2006, at 6.

Q8. Please identify the seven specific bases alleged by Dr. Landsman in his Declaration filed in support of this contention.

A8. As summarized by the Licensing Board in its Memorandum and Order of March 24, 2006, Dr. Landsman's Declaration 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.

Q9. Please describe the Alternate Cooling System ("ACS") at Vermont Yankee, and the purpose and function of this system.

A9. (SRJ) 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. Events that could result in all service water pumps becoming inoperable are a loss of the Vernon Pond inventory, flooding of the intake structure, or a fire in the intake structure. The system is designed to retain its function following design earthquake ground motion. Due to the low probability of these events, the ACS was not designed to maintain its function following a single failure, *i.e.*, the ACS need not meet the NRC's "single failure" criterion.

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.

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.

Q10.    Please describe the cooling tower structures at Vermont Yankee, and the ACS cooling tower cell.

A10.    (SRJ)  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 fan deck is 42 feet above ground level.  The cooling towers are constructed of treated wood with plastic fill and drift eliminators. The adjoining cell wall partitions are of fireproof construction, and the risk of a loss of the towers by fire is further reduced by the use of fire-resistant materials throughout.  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 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 is supported on rock for 9 of the 11 cooling cells.  This area, 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.

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 alternate cooling cell fan can be supplied by electric power from either site diesel generator.  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.

Q11. Please describe the modifications which have been made to the Vermont Yankee cooling towers to accommodate the EPU.

A11. (RBE, SRJ) As indicated in Section 1.4 of the Final SE, the cooling tower fan blades and motors have been replaced with higher efficiency blades and higher horsepower motors to provide for cooling tower plume control (*i.e.*, to address environmental and aesthetic issues). This modification involved 21 of the 22 cooling tower cells, including 10 of the cells located in the west cooling tower. The ACS cooling tower cell (*i.e.,* cell CT2-1 of the west cooling tower) fan and motor were not modified to implement the EPU.[10]

Q12. Do you agree with NEC's and Dr. Landsman's contention that the Applicant's ABS Report is "grossly deficient" or otherwise inadequate, with respect to the seven alleged inadequacies specified by Dr. Landsman?

A12. (DCJ) No.

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[10] As further indicated in Section 1.4 of the Final SE, a modification was made to the Residual Heat Removal Service Water (RHRSW) Piping, whereby the RHRSW pump motor bearing cooling water return line was modified to recover SW flow that was previously being discharged during ACS mode of operation of the pumps, such that this water will be returned to the ACS cell along with the cooling water supplied to other components. This modification was made because the EPU will increase the decay heat rate and will increase the evaporative losses from the ACS deep basin, so that the return of the cooling water from the bearing oil coolers is necessary to maintain the seven-day deep basin water inventory design requirement. This modification did not involve the ACS cooling tower.

Q13. Please describe the review you conducted and the conclusions you reached regarding this contention, based upon that review.

A13. (DCJ) In evaluating this contention, I reviewed the following documents:

(1) "New England Coalition's Request for Leave to File a New Contention," dated September 21, 2005;

(2) "Entergy's Response to the New England Coalition's Request for Leave to File a New Contention," dated October 19, 2005 (Entergy's Response);

(3) ABS Consulting Calculation No. 1356711-C-001,"Cooling Tower Seismic Evaluation," Rev. 1, dated April 5, 2005 (the "ABS Calculation" or "ABS Report"); and

(4) "Entergy's Motion to Dismiss as Moot, or in the Alternative, for Summary Disposition of New England Coalition Contention 4" dated July 13, 2005.

In addition, as part of my review I conducted a visit to the Vermont Yankee site, in which I performed a walkdown of the CT2-1 and CT2-2 cells of the west cooling tower and personally examined key structural elements of that structure, including the seismic breakaway ties and the bracing splices located at the end wall of the CT2-1 cell, referred to in NEC Contention 4.

Based on my review of the ABS Calculation and my walkdown of the Vermont Yankee west cooling tower, I am satisfied that the Applicant utilized appropriate assumptions; proper dynamic structural modeling; and the Vermont Yankee design basis earthquake input motions. Further, I found that 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. In addition, I have found that the Applicant's use of the SAP2000 finite element analysis computer code was acceptable; and it used a conservative evaluation of input parameters, appropriate load combinations, and an appropriate structural member capacity evaluation. Based upon my review, I have concluded that the Vermont Yankee ACS cooling tower is in compliance with the facility's original licensing basis , *i.e.*, Draft GDC 2. My review also led me to conclude that 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. Based on the above findings, I have 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. My views with respect to the various portions of NEC Contention 4 are set forth below.

**I. Failure to Conduct a Physical Examination of the Alternate Cooling Tower Cell**

Q14. NEC alleges that "ABS consultants do not claim to have conducted a physical examination of the alternate cooling tower cell." Landsman Declaration ¶ 8. Do you believe that this is a valid concern?

A14. (DCJ) No.

Q15. Please provide the bases for this conclusion.

A15. (DCJ) Entergy's Response to NEC's Request for Leave to File a New Contention, dated October 19, 2005, indicates that on March 29 and 30, 2005, Paul Baughman and Richard Augustine of ABS Consulting conducted a contractually-required walk-through inspection of each cell in each cooling tower. Baughman Declaration ¶¶ 8-10. They indicate 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 also state that 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. *Id.* Based on the above discussion of the ABS physical inspection, I conclude that the NEC's first alleged deficiency about the lack of a physical examination of the actual ACS is without factual basis and that 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.

Q16. Dr. Landsman also asserts that the ABS report fails to account for fill modifications in its seismic evaluation. Landsman Declaration ¶ 9. Do you believe this is a valid concern?

A16. (DCJ) No.

Q17. Please provide the bases for this conclusion.

A17. (DCJ) My review of the ABS Calculation, Section 6.2.1.7 (page 23 of 182) indicates that the current values of cooling tower fill water loadings were used in the seismic analysis. Therefore, I believe that the above "fill" related allegation by Dr. Landsman has no factual basis.

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

Q18. NEC alleges 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. Landsman Declaration ¶ 10. Do you believe that this is a valid concern?

A18. (DCJ) No.

Q19. Please provide the bases for this conclusion.

A19. (DCJ) NEC alleged that Entergy's seismic calculation should have taken into account the forces that could be transmitted from the Seismic Class II cells in CT-2 to the Alternate Cooling System cell and the cell adjacent to it. Entergy stated in its response to this allegation that the transmittal of earthquake loadings from the Seismic Class II cells to the

Alternate Cooling System cell and the cell adjacent to it is not possible because the connections between them will break under seismic forces. Baughman Declaration ¶ 11. Entergy explained that 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 in paragraph 10A of the Gunderson Declaration (August 2, 2005), referenced in paragraph 10 of the Landsman Declaration, but are made of wood, and 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. Baughman Declaration ¶ 11.

Entergy further explained that the ABS Calculation did not include these breakaway ties as load bearing elements because it only considered bolted structural connections as load bearing. The reason for excluding these nailed connections is that they have a small load carrying capacity as compared to bolted connections. As their name implies, these breakaway ties 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. Baughman Declaration ¶ 12.

As indicated in my response to Question 13 above, I 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. My inspection findings concerning the ties supports Entergy's assertion that these breakaway ties will break loose at low seismic levels and separate the Seismic Class I cells (*i.e.*, cells CT2-1 and CT2-2) from the Seismic Class II cells prior to the failure of the Seismic Class II cells, and will not transmit loadings of any significance from the Seismic Class II cells to the Seismic Class I cells. Based on my inspection finding and my evaluation of Entergy's engineering justifications for not including the breakaway ties in the seismic analysis model, I conclude that Entergy's engineering justifications are reasonable, are supported by good engineering practices, and are acceptable. I therefore agree that it was appropriate to exclude the breakaway ties from the seismic analyses, and that NEC's allegation is without merit.

Q20. NEC also alleges that horizontal forces will be transmitted to the Alternate Cooling System cell "through sixty-inch diameter heavy wall (1.2" thick) header pipe." Landsman Declaration ¶ 10. Do you believe that this is a valid concern?

A20. (DCJ) No.

Q21. Please provide the bases for this conclusion.

A21. (DCJ) The Baughman Declaration of October 17, 2005, attached to Entergy's response to NEC's request for leave to file a new contention, addressed this issue. Baughman makes clear that the piping in question (the circulating water distribution header) is made of sections of fiberglass pipe connected together through bell and spigot joints, and has only a ½-inch wall thickness. Thus, the piping is not strong enough to transmit horizontal loads from one cell to another, and can be disregarded in the analysis. In addition, the pipe is constructed with bell and spigot type joints, such that during seismic conditions the pipe will pull apart at the joints rather than transferring longitudinal loads from one cell to another. Thus, 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. Baughman Declaration ¶ 13. I have concluded that the Baughman Declaration describes good structural design practices, and eliminates any factual basis for this allegation. Based on my review of the Baughman Declaration and the Applicant's engineering assessment of this matter, I conclude that this allegation by NEC is without merit.

## III. Absence of Additional Conservatism

Q22. NEC alleges 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.” Landsman Declaration ¶ 12. Do you believe that this is a valid concern?

A22. (DCJ) No.

Q23. Please provide the bases for this conclusion.

A23. (DCJ) The Applicant has indicated that, as a part of their work in performing the ABS Calculation, Paul Baughman and Richard Augustine of ABS Consulting performed a walkdown inspection of the ACS, on March 29-30, 2005, to verify that the arrangement, member sizes, and connections details of the load bearing members were as shown on the drawings. Baughman Declaration ¶ 8. Paul Baughman and Richard Augustine also determined during the inspection that the structural components of the cooling towers and the accessible portions of the concrete foundations were in acceptable physical condition, and 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. Baughman Declaration ¶ 10. My observations during my walk-down of the west cooling tower foundation concrete at Vermont Yankee confirmed the Applicant’s findings. Therefore, I have concluded that NEC’s allegation related to the “as-found” condition lacks factual basis.

My review of the ACS Report indicates that 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.

With respect to NEC's concern regarding the aging of ACS structures, in addition to the above listed 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. Finally, with respect to NEC's concern that the ACS cooling tower operates in an adverse chemical environment, I am satisfied that there is no factual basis for this concern. The Vermont Yankee ACS cooling tower operates in a controlled chemical environment, such that there is no basis for a concern regarding chemically induced aging degradation.

For the reasons described above, I believe that NEC's alleged third deficiency fails to account for the seismic analysis performed or the environment in which the ACS cooling tower operates, and fails to give proper recognition to the plant's periodic structural inspection and deficiency correction programs. Based on my review of this matter, I have concluded that the concerns expressed by NEC in this portion of the contention are without merit.

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

Q24. NEC alleges that the ABS structural analysis is unconservative because it fails to assign a negative value to the replacement rate for degraded members. Landsman Declaration ¶ 13. Do you believe that this is a valid concern?

A24. (DCJ) No.

Q25. Please provide the bases for this conclusion.

A25. (DCJ) Neither the NRC regulations applicable to nuclear facility structural analysis and design, nor long-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. Specifically, Entergy conducts twice-a-year inspections of the cooling towers (Fall and Spring structural inspections of timbers, concrete, and other components of cells CT2-1 and CT2-2), 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 mechanical inspections of ACS cooling tower mechanical parts (*e.g.*, motors, gearboxes, etc.) are also implemented. 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 reasons, and the reasons provided in response to Question 23 above, I have concluded that NEC's concern regarding the seismic design adequacy and the structural integrity of the ACS cooling tower is without merit.

Q26. NEC alleges that "a cooling tower is only as strong as its weakest member and to retain original design conservatisms, one should even avoid using the AVERAGE age of structural components (due to replacement of portions), as the oldest will not behave like the average." Landsman Declaration ¶ 13. Does this assertion affect your conclusions regarding the need to assign a negative value to the replacement rate for degraded members?

A26. (DCJ) No.

Q27. Please provide the bases for this conclusion.

A27. (DCJ) This allegation 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, I have concluded that NEC's concern regarding the alleged use of an average age of structural components in the Applicant's ACS seismic analysis is without merit.

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

Q28. NEC alleges that the ABS report fails to account for changes to ACS after the report was completed. Landsman Declaration ¶ 14. Do you believe that this is a valid concern?

A28. (DCJ) No.

Q29. Please provide the bases for this conclusion.

A29. (DCJ) This alleged deficiency is related to two items, which had been identified in NRC Integrated Inspection Report 05000271 / 2005003 ("IR 2005-3") , 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 conducted under the Staff's oversight program for operating reactors. As discussed below, the two items referred to by NEC in this alleged deficiency were found to lack safety significance and were satisfactorily resolved.

*Installation of Temporary Splices*

The NRC inspection report provides documentation that the inspectors reviewed a temporary modification that had been made to the ACS cooling tower in accordance with Vermont Yankee Temporary Modification ("TM") 2005-004 ("Installation of Structural Splices in Cooling Tower CT2-1"). *See* IR 2005-3, ¶ 1R23 at 7.[11] I have reviewed the referenced NRC Inspection Report, as well as Vermont Yankee Temporary Modification Package TM No. 2005-004. The purpose of the temporary modification was to restore the integrity of the degraded diagonal brace located on the north wall of Cooling Tower 2 (cell CT2-1). The degraded condition was described as longitudinal cracking at the end of a main diagonal brace member in the vicinity of the brace plate connection bolts. This condition caused a reduction in the load carrying capacity of the individual brace. The bracing capacity was restored to full load

[11] The NRC Inspection Report incorrectly recited the title of TM 2005-004 as "Installation of Structural Steel Splices in Cooling Tower CT 2-1." IR 2005-3, 1R23 at 7; emphasis added. As indicated in the text above, the correct title of TM-2005-004 is "Installation of Structural Splices in Cooling Tower CT2-1," and the splices were actually made of 4"x4" Douglas fir rather than "structural steel."

carrying capability by the installation of a temporary splice. The splice was described as follows in TM-2005-04:

> The temporary splice process consists of removing the damaged end section of the 4"x4" PT [pressure-treated] Douglas Fir diagonal brace (approximately 30") and inserting an equal size section of new 4"X4" Douglas Fir. The new connection will be connected or "spliced" to the existing brace member by adding two 4"x4" members of new PT Douglas Fir to the top and bottom of the joint. The 4x4 splice pieces will be securely attached to the brace by through-bolting with high strength threaded steel rods.

The NRC inspection verified that the temporary modification did not affect the system's operability, and the Inspection Report indicates that the inspectors identified no findings of significance in connection with the temporary modification. IR 2005-3, ¶ 1R23 at 8. This finding confirmed that the temporary modification did not impair the safety function of the ACS.

*Degradation of Cooling Basin Concrete*

The NRC inspection report indicates that the inspectors evaluated seven operability determinations made by Entergy, including "damage to alternate cooling deep basin cement wall." IR 2005-3, ¶ 1R15 at 6. 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 the damage to the alternate cooling deep basin cement wall and concluded that no finding of significance was identified. *Id.*

The two above cited inspection items were identified as part of the NRC's routine reactor operation safety oversight activities. 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.

Finally, the Applicant's consultants from ABS Consulting determined that the accessible portion of the concrete foundations was in acceptable physical condition, and my walkdown of the repaired portion of the concrete foundation found it to be in sound condition. For these reasons, I have concluded that NEC's concern regarding these two Inspection Report items is without merit.

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

Q30. NEC alleges that the ABS Report improperly relies on the assumption that concrete always strengthens with time. Landsman Declaration ¶ 15. Do you believe that this is a valid concern?

A30. (DCJ) No.

Q31. Please provide the bases for this conclusion.

A31. (DCJ) I believe that this alleged deficiency 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. Based on my review of the ABS Calculation, I am satisfied that there is no reason to believe that the cooling towers are exposed to a "caustic" environment. To the contrary, the discharge 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.[12] Thus, contrary to NEC's assumption, the actual condition of the installed concrete in the cooling tower foundations is not different from that assumed in the calculation.

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[12] *See* State of Vermont Discharge Permit No. 3-1199, enclosed as Attachment 13 to "Entergy's Response to the New England Coalition's Request for Leave to File A New Contention," dated October 19, 2005, and Entergy's Response of October 19, 2005, at 26.

With respect to NEC's concern regarding aging and its effects on the "tension characteristics" of the reinforced concrete, this is not a valid concern, in that (a) concrete is always used as a compressive stress resisting material and, although concrete has some tensile strength before it cracks, it 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 for the purpose of determining the allowable reinforced concrete column compressive load-bearing capacity, anchor bolt load bearing capacity, and the flexural capacities of reinforced concrete beams or slabs. Accordingly, the so-called "tension characteristics" of reinforced concrete is, in my opinion, not relevant to the seismic capacity calculation.

Q32. NEC alleges that the ABS report improperly relies on a seismic damping ratio for wooden structures even though "structural steel splices" were implemented. Landsman Declaration ¶ 16. Do you believe that this is a valid concern?

A32. (DCJ) No.

Q33. Please provide the bases for this conclusion.

A33. (DCJ) This alleged deficiency consists of two items. The first item alleged that the ABS evaluation mistakenly relies on a seismic damping ratio for wooden structures, in that "5 percent of critical damping is used in the analysis for the MHE." Landsman Declaration ¶ 16. This concern fails to recognize that NRC practice allows the use of <u>10 to 15 percent</u> of critical damping in a seismic analysis of bolted wooden structures that may be subject to Vermont Yankee's MHE level earthquake motions.[13] Since the ABS Calculation conservatively used a damping ratio of 5 percent for the MHE analysis, which is much lower than the 10 to 15 % value allowed, the ABS analysis is acceptable. Therefore, NEC's concern about the damping value used is without merit.

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[13] *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.

The second item alleged by NEC is that the ABS Report did not take into account the changes made to the structure by the introduction of “structural steel splices” referenced in NRC Inspection Report 2005-3, at ¶ 1R23. Landsman Declaration ¶ 16. Based on my review of the referenced NRC Inspection Report, and Vermont Yankee Temporary Modification Package TM No. 2005-004, “Installation of Structural Splices in Cooling Tower CT2-1," I have concluded that this is not a valid concern. As discussed above in response to Question 29, the purpose of the temporary modification was to restore the integrity of the degraded diagonal brace located on the north wall of Cooling Tower 2 (cell CT2-1). The degraded condition was described as longitudinal cracking at the end of a main diagonal brace member in the vicinity of the brace plate connection bolts. The scope of the temporary modification consisted of removing the damaged end section of the 4"x4" PT Douglas Fir diagonal brace (approximately 30" long) and inserting an equal sized section of new 4"x4" PT Douglas Fir. The new section was connected or spliced to the existing brace member by adding two 4"x4" members of new PT Douglas Fir to the top and bottom of the joint. The 4"x4" wooden splice pieces were securely attached to the brace by through-bolting with high strength threaded steel rods. Since only a single splice made of Douglas Fir (the same Douglas Fir material as the remainder of the towers, not a steel member) was installed and no structural steel splices were installed, there is no basis for alleging that the conservatively selected 5% damping value for the Douglas Fir wooden cooling tower structure is no longer acceptable. Further, hundreds of steel bolts are already in place as part of the CT2 cooling tower (a bolted wooden structure). Engineering experience indicates that there should be no appreciable impact on either the seismic response or the structural capacity of the CT2 cooling tower structure, resulting from the additional use of six 3/4-inch diameter steel bolts for the wooden splice when compared to the large number of bolts already in place in the cooling tower. For all the above reasons, this concern is without merit.

In expressing this concern, Dr. Landsman further stated his opinion that where "structural steel splices" have been applied as identified in IR-2005-03 at 1R23, these splices may add rigid nodes or fulcra to the structure. In his opinion, credit for flexibility (friction and slippage) in bolted wooden joints must be re-examined following completion of any such modifications. Landsman Declaration ¶ 17. These statements appear to reflect an incorrect understanding of the nature of the brace modification that was performed. As discussed above, a relatively small (30-inch) length of a longitudinally cracked 4"x4" Douglas Fir diagonal brace section was replaced with a new Douglas Fir wood section of identical dimensions and material plus two wooden splice pieces (4"x4" section, 2'-2" long) connected by six steel through bolts. Such modifications are considered to be a minor repair for such a wooden structure, and are consistent with accepted structural engineering practices; moreover, I am satisfied that 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.

## VII. ABS Does Not Provide Reasonable Assurance of Seismic Qualification

Q34. NEC alleges that the ABS report fails to provide reasonable assurance of that Vermont Yankee's cooling towers would be able to withstand a design basis earthquake under extended power uprate conditions. Landsman Declaration ¶ 18. Do you believe that this is a valid concern?

A34. (DCJ) No.

Q35. Please provide the bases for this conclusion.

A35. (DCJ) NEC's seventh alleged deficiency appears to be based on its 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. This appears, however, to be a conclusory statement. It alleges no new facts and is apparently drawn from the previously listed alleged deficiencies. Since those alleged deficiencies are faulty, as discussed above, the conclusions drawn from them by NEC are erroneous.

Q36. NEC alleges that the Vermont Yankee design basis earthquake is non-conservative. Landsman Declaration ¶ 18. Do you believe that this is a valid concern for EPU operation?

A36. (DCJ) No.

Q37. Please provide the bases for this conclusion.

A37. (DCJ) 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. NEC here appears to dispute the validity of the established, NRC-approved Vermont Yankee licensing basis earthquake. Selection of a design basis earthquake, however, 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.

Q38. Having reviewed the assertions presented by Dr. Landsman in support of NEC Contention 4, have you reached a conclusion as to the adequacy of the Applicant's seismic and structural analysis of the ACS cooling tower cell, presented in the ABS Report?

A38. (DCJ) Yes. Based upon my review of each of the seven deficiencies alleged by NEC, the ABS Report, the documentation provided by NEC in support of the contention, and the documentation provided by Entergy in opposition thereto, and based upon my personal observation of the ACS cooling tower and other structures, I am satisfied 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.

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.

Accordingly, I conclude that 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.

Q39. Does this conclude your testimony?

A39. Yes.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF DAVID C. JENG
CONCERNING NEC CONTENTION 4

I, David C. Jeng, being first duly sworn, do hereby aver that my statements in the foregoing "NRC Staff Testimony of David C. Jeng, Steven R. Jones and Richard B. Ennis Concerning NEC Contention 4" are true and correct to the best of my knowledge, information and belief.

***/Original Signed By/***
________________________
David C. Jeng

Subscribed and sworn to before me
this 17th day of May, 2006

***/Original Signed By/***
________________________
Notary Public

My commission expires: March 1, 2010

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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| (Vermont Yankee Nuclear Power Station) | ) | |

AFFIDAVIT OF STEVEN R. JONES
CONCERNING NEC CONTENTION 4

I, Steven R. Jones, being first duly sworn, do hereby aver that my statements in the foregoing "NRC Staff Testimony of David C. Jeng, Steven R. Jones and Richard B. Ennis Concerning NEC Contention 4" are true and correct to the best of my knowledge, information and belief.

______________________
Steven R. Jones

Subscribed and sworn to before me
this 17th day of May, 2006

______________________
Notary Public

My commission expires: ____________

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF RICHARD B. ENNIS
CONCERNING NEC CONTENTION 4

I, Richard B. Ennis, being first duly sworn, do hereby aver that my statements in the foregoing "NRC Staff Testimony of David C. Jeng, Steven R. Jones and Richard B. Ennis Concerning NEC Contention 4" are true and correct to the best of my knowledge, information and belief.

***/Original Signed By/***

Richard B. Ennis

Subscribed and sworn to before me
this 17th day of May, 2006

***/Original Signed By/***

Notary Public

My commission expires: March 1, 2010

# RICHARD B. ENNIS
**Statement of Professional Qualifications**

**CURRENT POSITION:**

Senior Project Manager — Division of Operating Reactor Licensing, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Rockville, MD

**EDUCATION:**

B.S. in Electrical Engineering, Bucknell University, 1977

**SUMMARY:**

Over 28 years engineering experience in the commercial nuclear power industry. Significant experience in the following areas:

- Project Management
- Technical Writing
- Design & Licensing Basis Documentation
- License Renewal
- Nuclear Facilities Audits and Design Verifications
- Design Modifications
- Instrument Setpoint and Loop Uncertainty Calculations & Methodologies
- Software Development, Quality Assurance, and Verification & Validation

**EXPERIENCE:**

**U.S. Nuclear Regulatory Commission, Project Manager, 1998 - Present**

Project Manager in the Office of Nuclear Reactor Regulation. Serve as headquarters focal point for technical review coordination, information and communication on issues concerning assigned nuclear power plants. Responsibilities include coordination, review, and preparation of safety evaluations, environmental evaluations and other documentation to support the licensing activities for the plant. Also serve as lead project manager for special projects. Assignments have included the following:

- Lead Project Manager, Vermont Yankee Extended Power Uprate (10/05 - Present)
- Project Manager, Vermont Yankee Nuclear Power Station (12/03 - 10/05)
- Project Manager, Millstone Nuclear Power Station, Unit 2 (3/02 - 12/03)
- Project Manager, Hope Creek Generating Station (3/98 - 6/00, 11/00 - 3/02, 5/03 - 9/03)
- Lead Project Manager, Steam Generator Action Plan (11/00 - 6/01).

- Lead Project Manager, Indian Point Unit 2 Steam Generator Tube Failure Lessons-Learned Task Group (6/00 - 11/00).

**Scientech, Inc., Senior Engineer, 1997 - 1998**

Worked as a contractor for Baltimore Gas and Electric Company in the Calvert Cliffs Nuclear Power Plant (CCNPP) Life Cycle Management Group. Prepared technical reports for the CCNPP license renewal application to the NRC in accordance with 10 C.F.R. Part 54. Reports prepared for the Radiation Monitoring System, Chemical and Volume Control System, Saltwater System, Electrical Cables Commodity Evaluation, Instrument Lines Commodity Evaluation, Intake Structure, and Turbine Building.

**TENERA, Inc., Project Manager/Senior Engineer, 1988 - 1996**

Responsibilities included technical consulting, project management, budget and schedule control, marketing and business development, and preparation of proposals. Also served as corporate Configuration Control Manager (CCM) for development of computer software applications. CCM responsibilities included ensuring that software life cycle activities were implemented in accordance with quality assurance (QA) requirements. Managed and provided engineering support for numerous projects as described below.

- Commonwealth Edison Company - Managed and performed a license conformance review at the LaSalle plant that included developing plant licensing and design basis requirements from the UFSAR and reviewing these requirements against design documents and procedures (e.g., operations, maintenance, engineering) to ensure that the plant was operating within its design and licensing basis.

- Commonwealth Edison Company - Performed design basis verification for the Auxiliary Power System for Zion Station Units 1 and 2, and Standby Gas Treatment System for Dresden Station.

- Nebraska Public Power District - Authored the Reactor Protection System (RPS), Standby Liquid Control System, and Neutron Monitoring System design basis documents for Cooper Nuclear Station. Also performed design basis verification for the Reactor Protection, DC Electrical, Diesel Generator, Standby Liquid Control, Neutron Monitoring, and Control Rod Drive systems.

- Northern States Power Company - Performed reactor trip instrument setpoint calculations for Prairie Island Units 1 and 2.

- Northeast Utilities - Authored the RPS Equipment Coefficients Methodology for Millstone Unit 2. Also performed fuel reload analysis for fuel cycle 13.

- New York Power Authority, Consolidated Edison Company - Authored engineering evaluations and documents related to Electrical Separation for the FitzPatrick and Indian

Point Unit 2 nuclear plants. Work included preparation of Electrical Separation Design Criteria documents, justifications for cable separation anomalies, review of cable and raceway installation standards, fault current analysis, and preparation of a training package.

- Philadelphia Electric Company - Authored the Regulatory Guide 1.97 Post-Accident Monitoring design basis documents for Limerick Generating Station and Peach Bottom Atomic Station.

- Florida Power and Light Company - Co-authored the RPS Equipment Coefficients Methodology for St. Lucie Unit 1. Also performed calculations to verify the methodology and performed fuel reload analysis for fuel cycles 12, 13, and 14.

- Portland General Electric Company - Performed audit of the setpoint control program for Trojan Nuclear Plant.

- Washington Public Power Supply System - Performed system review (mini-SSFI) of Process Radiation Monitoring System for WNP-2.

- Southern California Edison Company, Arizona Public Service Company, Baltimore Gas and Electric Company, Northern States Power Company, Wisconsin Public Service Corporation - Developed QA computer software applications for San Onofre Nuclear Generating Station, Palo Verde Nuclear Generating Station, Calvert Cliffs Nuclear Power Plant, Prairie Island Nuclear Generating Station, and Kewaunee Nuclear Power Plant. Software packages included instrument-related databases and reports, setpoint calculations, instrument calibration scaling, head correction calculations, and insulation resistance calculations. Work included full life cycle development of QA Verified and Validated (V&V) software applications in IBM PC DOS and Windows environments.

- Consolidated Edison Company - Prepared design modification package for Emergency Diesel Generator Building HVAC System for Indian Point Unit 2.

- System Energy Resources, Inc. - Performed FSAR review and updates for Grand Gulf Nuclear Power Station.

**<u>Bechtel Power Corporation, 1977 - 1988</u>**

Assignments were as follows:

- Instrument and Controls Group Leader and Electrical/Control Systems Deputy Supervisor, Davis-Besse Nuclear Power Station, Gaithersburg, MD (4/85 - 11/88). Supervised Electrical/Control Systems group (approximately 40 engineers). Coordinated and reviewed design work including revision and issue of the following types of documents: specifications, control board layouts, loop diagrams, instrument installation details, tubing isometrics, instrument index, setpoint index, P&ID's, electrical schematics, connection diagrams, safety evaluations and conceptual designs.

Responsible for design and specification of instrumentation and controls equipment. Responsible for preparing schedules, man-hour estimates, and staffing requirements.

- Results Engineering Group Leader, Wolf Creek Generating Station, New Strawn, KS (1/83 - 4/85). Supervised instrument and controls engineers in Results Engineering group (approximately 10 engineers). Coordinated all work related to generation of Wolf Creek instrument calibration documents. Reviewed instrument calibration data and prepared setpoint calculations. Generated startup field reports and processed instrument change requests. Reviewed startup test procedures and test results and wrote engineering procedures. Coordinated with instrument and controls maintenance group and startup group to support component and system tests.

- Instrument and Controls Group Leader, Grand Gulf Nuclear Power Station, Gaithersburg, MD (1/81 - 1/83). Supervised instrument and controls engineers in systems group (approximately 6 engineers). Coordinated and reviewed design work including logic diagram, loop diagram, and P&ID revisions; instrument calibration data; and design changes to comply with new licensing requirements.

- Instrument and Controls Engineer, Grand Gulf Nuclear Power Station, Gaithersburg, MD (7/79 - 1/81). Designed logic, loop and level settings diagrams. Prepared instrument calibration data and wrote instrument purchase specifications and evaluated bids. Prepared stress and seismic calculations and resolved startup field reports and field change requests.

- Instrument and Controls Engineer, Davis-Besse Nuclear Power Station, Gaithersburg, MD (7/77 - 7/79). Designed logic diagrams and prepared control valve specifications. Completed valve data sheets and ran computer program for instrument index updating.

# David C. Jeng

## Statement of Professional Qualifications

EXPERIENCE:

Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission
Rockville, MD

Senior Structural Engineer, Geoscience
and Civil Engineering Branch: June 1994 - Present

Performed evaluations of structural integrity, seismic design adequacy and functionality of nuclear power plant structures, including containments, other safety related structures and structural supports, subject to various combinations of operating loads, design basis accident loads and earthquake loads. Reviewed these nuclear facility structures to ensure compliance with NRC regulations in 10 C.F.R. Part 50 and Part 54, applicable General Design Criteria, Regulatory Guides, Standard Review Plan and industry standards. The complex technical issues reviewed include: steel and concrete containments seismic capability and structural fragility evaluation; soil-structural interaction analysis of a nuclear power plant complex interacting with its supporting medium; foundation settlement analysis; design adequacy determination of nuclear steam supply system (NSSS) support structures; design adequacy determination of other category I structures; dynamic finite element analysis of containment and containment interior structures; non-linear finite element analysis of spent fuel pool interaction with spent fuel racks subject to safe shutdown earthquake motions; design adequacy determination of cable trays, conduits, cabinets, and their supports; seismic capacity evaluation of safety related tanks and buried pipes; design adequacy assessment of intake, ultimate heat sink and other water control structures; structural reliability and fragility analysis; evaluation of issues encountered in operating reactor safety oversight related tasks (e.g., corrosion of Mark I drywall, leakage of spent fuel pools, cracking of stainless steel bellows, corrosion of rebars); evaluation and disposition of licensees' facility license amendment requests and various relief requests; evaluation of operating plant license renewal applications; design certification review of advanced reactors (APWRs and ABWRs); technical assistance to NRC regional offices, and technical support to the NRC Office of Nuclear Regulatory Research (RES) in its implementation of nuclear regulatory research. Evaluated technical safety issues involving steel liner and drywall corrosion, and degradation of concrete structures located in inaccessible areas, and presented briefs regarding the resolution of these issues to NRC senior management and the Advisory Committee on Reactor Safeguards (ACRS).

Section Chief, Geoscience and
Civil Engineering Branch February 1975 - June 1994

As section chief, I supervised the section staff in performing evaluations of structural integrity, seismic design adequacy and functionality of nuclear power plant structures (including containments, other safety related structures and structural supports), subject to various combinations of operating loads, design basis accident loads and earthquake loads. The primary safety review responsibility of the section consisted of (1) structural safety review of applications for new plant construction permits (CPs) and operating licenses (OLs), (2) safety review of ABWR and APWR design certification applications, covering structural integrity and seismic design adequacy, and (3) structural safety review of issues arising from NRC's operating reactors safety oversight work. As section chief, I also directed my staff in contributing to the development and formulation of NRC Standard Review Plans and related regulatory guides addressing safety review criteria for ensuring structural integrity and seismic design adequacy of nuclear facility structures. The section also contributed to operating experience analysis and resolution of associated generic safety issues related to containments and other category I structures. Among the key issues reviewed by the section include: steel and concrete containments seismic capability and structural fragility evaluation; soil-structural interaction analysis; foundation settlement analysis; design adequacy determination of NSSS support structures; dynamic finite element analysis of containment and containment interior structures; non-linear finite element analysis of spent fuel pool interaction with spent fuel racks subject to safe shutdown earthquake; seismic capacity evaluation of safety related tanks and buried pipes; and design adequacy assessment of intake, ultimate heat sink and other water control structures.

Senior Structural Engineer, Geoscience and
Civil Engineering Branch — March 1973 - February 1975

As a senior structural engineer, I performed safety reviews of nuclear facility structures covering technical issues including: steel and concrete containments seismic capability and structural fragility evaluation; soil-structural interaction analysis; foundation settlement analysis; design adequacy determination of NSSS and balance-of-plant (BOP) structures; dynamic finite element analysis of containment and containment interior structures; non-linear finite element analysis of spent fuel pool and spent fuel racks; seismic capacity evaluation of safety related tanks and buried pipes; and design adequacy assessment of intake and other water control structures.

Gulf Energies & Environmental Systems, San Diego, CA

Structural Lead Engineer, Gulf General Atomic Co. — February 1968 - March 1973

As a structural lead engineer, I participated in various engineering projects including: review and commenting on NSSS- and BOP-related final safety analysis report (FSAR); seismic and structural design criteria development for a high temperature gas-cooled reactor (HTGR); finite element analysis of HTGR containment; review and approval of architect/engineer's BOP design; technical assistance to General Atomic's site construction team; NSSS license application work, and preparation of the NSSS portion of an FSAR.

Kaiser Engineers, Oakland, CA

Structural Engineer November 1966 to February 1968

During my employment with Kaiser Engineers, I contributed to several projects including: finite element analysis and design of the bottom head of the containment structure for STEP/LOFT; structural analysis and design of the NASA-sponsored engine stage testing stand nuclear rocket engine EST/E 2-3, and analysis and design of a six million gallon prestressed concrete water tank.

P.B.Q. & D., Inc., San Francisco, CA

Structural Engineer May 1964 - November 1966

During my employment with P.B.Q. & D. Inc., I contributed to several projects including: analysis and design of subway stations; foundation settlement analysis; Cross-Bay soil exploration for the San Francisco bay tube construction; design of tunnel linings and finite element analysis of subway structures.

Missouri Highway Commission, Jefferson City, MO

Bridge Engineer, Bridge Design Department January 1963 - May 1964

Served as a bridge design engineer designing various highway bridges including a multi-span continuous highway bridge.

EDUCATION:

B.S.C.E: 1955
National Chengkuong University
Tainan, Taiwan

M.S.C.E.: 1963
Oklahoma State University
Stillwater, Oklahoma

QUALIFICATIONS AND TRAINING:

Training Courses:
- Westinghouse Technology
- General Electric Technology
- PRA Technology and Regulatory Perspectives
- Perspectives on Reactor Safety
- Root Cause/Incident Investigation Workshop
- PRA Basics for Regulatory Applications

CERTIFICATES AND LICENSES:

Licensed Professional Engineer (Civil): California, 1966

Licensed Professional Engineer (Civil): Taiwan, 1956

INDUSTRY CODES AND STANDARDS MEMBERSHIP:

Member of ACI/ASME Joint Committee on Code for Concrete Reactor and Containments 1995 - 2005

PUBLICATIONS:

1. “Transient Seismic Analysis of HTGR Nuclear Power Plants,” Gulf General Atomic Co., San Diego, CA 92112, USA, Nuclear Engineering and Design 21 (1972) 358-367, North-Holland Publishing Co.

2. “Soil-Structure Interaction Effects on HTGR Seismic Response.” Fifth World Conference on Earthquake Engineering, June 1973, Rome

3. “Development of In-House Analytical Capability and Its Application for Advanced Reactor Reviews,” NUREG/BR-0125, Vol. 4, No.2, October 1992

4. ”Seismic Design Criteria, Nuclear Steam Supply Systems,” December 1970, Gulf General Atomic Co.

5. “Stress Analysis Report for Prestressed Concrete Off-Shore Storage Facility,” December 1970, Gulf General Atomic Co.

6. “Ultimate Load Analysis of Prestressed Concrete Reactor Vessel (PCRV) Heads,” October 1969, Gulf General Atomic Co.

7. “Design Report: Pre-stressed Concrete Reactor Vessel for 330 MW(e) Fort St. Vrain Nuclear Power Station,” June 1969, Gulf General Atomic Co. (General Atomic Design Report (GADR))

8. “Quasi-Analytical Evaluation of Thick Concrete Slab Ultimate Load Capacities,” April 1969, Gulf General Atomic Co.

9. “Ultimate Load Analysis of PCRV Anchor Zone by Visco-elastic Finite Element Techniques,” March 1970, Gulf General Atomic Co. (GADR)

10. “Time-History Approach in Seismic Response Analysis of Integrated Nuclear Power Plants,” July 1970, Gulf General Atomic Co.

11. “An Investigation of PCRV Shear Anchor Stresses,” May 1968 Gulf General Atomic Co.

12. “An Analysis and Brief Design of Two Span Reinforced Concrete Gable Frame,” May 1963, M.S.C.E. Dissertation

# Steven R. Jones

Statement of Professional Qualifications

EXPERIENCE:

Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission

Acting Chief, Balance of Plant Branch: November 2004 - Present

Supervised the safety review of mechanical systems other than those directly associated with the nuclear steam supply system, which are referred to as "Balance-of-Plant" systems. In this capacity, I have supervised the NRC Staff's technical review of Balance-of-Plant systems review activities related to operating reactor license amendment requests (e.g., power uprate license amendment requests), aging management program scope for license renewal, design certification of new reactor designs, and operating experience analysis and resolution of associated generic safety issues.

Senior Reactor Systems Engineer: August 2001 - Present
Reactor Systems Engineer: October 1990 - June 1997

Performed evaluations of significant changes in design or operational limits and other technical issues related to secondary safety systems at commercial nuclear power plants, with a focus on service water cooling systems, power conversion systems, compartment transient analysis, spent fuel storage, and control room habitability. Assessed system capability and potential system failure modes. Reviewed system design to verify compliance with NRC regulations, applicable regulatory guidance, and industry standards. Evaluated technical safety issues involving spent fuel cooling and other secondary safety systems, and presented briefs regarding resolution of these issues to NRC senior management, the NRC Chairman, and advisory committees. Evaluated research reports related to secondary safety systems and recommended direction for future research activities.

NRC Region I, U.S. Nuclear Regulatory Commission

Senior Resident Inspector / Resident Inspector: June 1997 - July 2001

Planned and led implementation of the resident inspection program at Millstone Unit 2 under the revised Reactor Oversight Program. Monitored plant management performance and the conduct of operational, maintenance, and engineering activities at the unit with respect to the maintenance of reactor safety and compliance with NRC regulations. Evaluated the capability of important structures, systems, and components to perform their functions under limiting design conditions, based on mechanical design, fluid dynamics, heat transfer, electrical circuit analysis, control systems, and other technical considerations. Verified that the physical condition, maintenance practices, and operating procedures were consistent with maintaining the reliability of associated structures, systems, and components in performing their design functions. Used knowledge of risk analysis and the NRC's Significance Determination Process to evaluate several inspection findings involving degraded performance of essential mitigating systems. Analyzed the causes of degraded conditions to develop meaningful assessments of plant management performance and corrective action program effectiveness. Developed written reports to document technical issues and NRC performance assessments.

United States Navy

Nuclear Power Trained Submarine Officer: 1984 - 1989

Responsible for nuclear propulsion plant operations on board nuclear-powered submarine USS Simon Bolivar (SSBN-641). Developed an excellent understanding of design principles and operational characteristics of systems supporting submarine operations and systems associated with naval pressurized water reactors. Utilized principles of system design and operating characteristics to effectively execute the ship's operational mission and ensure safety during maintenance and testing activities. Enforced high standards of safety and workmanship during maintenance and repair periods through frequent inspection.

EDUCATION:

B.S., Marine Engineering, 1984
U. S. Naval Academy, Annapolis, MD

Graduate Studies in Mechanical Engineering, 1992 – 93
University of Maryland, College Park, MD

QUALIFICATIONS AND TRAINING:

Qualified NRC Operations Inspector (PWR), 1998
Qualified Submarine Officer, U. S. Navy, 1989
Qualified Engineering Officer of the Watch/Engineering Duty Officer, U. S. Navy, 1987

Training Courses:

- Westinghouse Technology (full series)
- Combustion Engineering Technology (cross-training series)
- General Electric Technology (short course)
- PRA Technology and Regulatory Perspectives (P-111)
- Perspectives on Reactor Safety (R-800)
- Root Cause/Incident Investigation Workshop (G-205)
- Reactor Inspection and Oversight Program (G-200)
- PRA Basics for Regulatory Applications (P-105)
- Inspecting for Performance (G-303)
- Fundamentals of Inspection (G-101)

CERTIFICATES AND LICENSES:

Licensed Professional Engineer (Mechanical): Maryland, 1996