UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF KAIHWA R. HSU,
JONATHAN G. ROWLEY, AND THOMAS G. SCARBROUGH
CONCERNING NEC CONTENTION 3 (STEAM DRYER)

Q1. Please state your name, occupation, and by whom you are employed.

A1(a). My name is Kaihwa R. Hsu ("Hsu").[1] I am employed by the Nuclear Regulatory Commission ("NRC") as a senior mechanical engineer in the Division of Engineering in the Office of New Reactors ("NRO"). Previously I was employed as a materials engineer in the Office of Nuclear Reactor Regulation ("NRR") Division of License Renewal ("DLR"). A statement of my professional qualifications is attached hereto.

A1(b). My name is Jonathan G. Rowley ("Rowley"). I am employed by the NRC as a project manager in NRR/DLR. A statement of my professional qualifications is attached hereto.

A1(c). My name is Thomas G. Scarbrough ("Scarbrough"). I am employed by the NRC as a senior mechanical engineer in the NRO Division of Engineering. Previously, I was assigned as a senior mechanical engineer in the NRR Division of Component Integrity. A statement of my professional qualifications is attached hereto.

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[1] In this testimony, the sponsors of each numbered response are identified by their last name; no such designation is provided for paragraphs which are sponsored by all witnesses.

Q2. Please explain your duties in connection with the staff's review of the License Renewal Application ("LRA") submitted by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. ("Entergy," "Applicant," "Vermont Yankee," or "Licensee").

A2(a). (Hsu) In connection with the staff's review of the LRA, I was an Audit Team Member for the license renewal safety audit at Vermont Yankee. I served as technical lead for activities related to the Vermont Yankee LRA. I also reviewed the Vermont Yankee LRA including the following aging management programs: B.1.4, "BWR Penetrations;" B.1.5, "BWR Stress Corrosion Cracking;" B.1.6, "BWR Vessel ID Attachment Welds;" B.1.7, "BWR Vessel Internals;" and B.1.29, "Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel," including preparation of Section 3.0.3.1.2 of the Safety Evaluation Report. I also reviewed the Time-Limited Aging Analysis and prepared Sections 4.1, 4.3 and 4.7 of the Safety Evaluation Report.

A2(b). (Rowley) I am the lead project manager for the staff's safety review of the Vermont Yankee license renewal application. I serve as the principal point of contact in NRR for activities related to the Vermont Yankee LRA. I coordinated the staff's evaluation of Vermont Yankee LRA and preparation of the staff's Safety Evaluation Report with Confirmatory Items, which was issued to the public in March 2007. In addition, I coordinated the staff's final Safety Evaluation Report, which was issued to the public in February 2008.

A2(c). (Scarbrough) I have not participated in the staff's review of Vermont Yankee's LRA. However, as part of my official responsibilities, I participated in the review of potential adverse flow effects on nuclear power plant components (including

the steam dryer) from the proposed operating conditions for the Vermont Yankee Extended Power Uprate ("EPU") license amendment request, including assisting in the preparation of the Section 2.2.6, "Additional Review Area - Potential Adverse Flow Effects," of the staff's Safety Evaluation ("SE") issued on March 2, 2006 (Staff Exh. 14).

Q3. What is the purpose of your testimony?

A3. The purpose of this testimony is to present the staff's position regarding NEC Contention 3 (Steam Dryer). As admitted by the Board, LBP-06-20, 64 NRC 131, 187-191 (2006), NEC's contention alleges that "Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation." We have read relevant portions of the SER; LPB-06-20, 64 NRC 131 (2006); NEC's "Petition for Leave to Intervene, Request for Hearing and Contentions" (May 26, 2006); "Entergy's Motion for Summary Disposition of New England Coalition's Contention 3 (Steam Dryer)" (Apr, 19, 2007); NEC's "Opposition to Entergy's Motion for Summary Disposition of NEC's Contention 3 (Steam Dryer)" (May 9, 2007); NEC's "Supplement to Opposition to Entergy's Motion for Summary Disposition of New England Coalition Contention 3 (Steam Dryer)" (July 19, 2007); and "Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 3)" (Sept. 11, 2007) (unpublished).

Q4. Describe Entergy's program to monitor and manage the effects of aging on Vermont Yankee's steam dryer during the period of extended operations.

A4(a). (Rowley) Entergy has committed (SER Commitment No. 37) (Staff Exh. 1) to continue inspections in accordance with its Steam Dryer Monitoring Plan ("SDMP"), Revision 3, in the event that the Boiling Water Reactor and Vessel Internals Project ("BWRVIP")-139 "Steam Dryer Inspection and Flaw Evaluation Guidelines," is not

approved prior to the period of extended operation. The BWRVIP is the BWR Vessels and Internals Project of the nuclear industry with participation by the Electric Power Research Institute ("EPRI"). The BWRVIP Steam Dryer Focus Group developed guidelines for steam dryer inspections and flaw evaluation in BWRVIP-139.

A4(b). (Scarbrough) Entergy described its SDMP for monitoring and evaluating the performance of the Vermont Yankee steam dryer during power ascension testing and operation above then-Current Licensed Thermal Power ("CLTP") to full EPU conditions in Attachment 6 to Supplement 33 (dated September 14, 2005) of its EPU license amendment request. Entergy defined unacceptable steam dryer performance as a condition that could challenge steam dryer structural integrity and result in the generation of loose parts, cracks or tears in the dryer that result in excessive moisture carryover.

As planned in the SDMP, Entergy monitored plant parameters during the EPU power ascension following issuance of the EPU license amendment on March 2, 2006, to confirm that pressure loads on the steam dryer resulted in stresses that remained below the fatigue stress limits in the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code. In its SDMP, Entergy stated that the Vermont Yankee steam dryer would be inspected during refueling outages scheduled for fall 2005, spring 2007, fall 2008, and spring 2010, according to recommendations in GE Services Information Letter (SIL) No. 644, Revision 1 (November 9, 2004). The SDMP indicates that moisture carryover measurements will continue to be made periodically, and other plant operational parameters that may be affected by steam dryer structural integrity will continue to be monitored, in accordance with GE SIL 644 and plant procedures. In the EPU License Amendment dated March 2, 2006 (ML060390107) (Staff Exh. 14), the

NRC established license conditions related to the EPU power ascension and long-term steam dryer monitoring. For example, License Condition 5 specifies that during each of three scheduled refueling outages (beginning with the spring 2007 refueling outage), a visual inspection shall be conducted of all accessible, susceptible locations of the steam dryer, including flaws left "as is" and modifications. License Condition 6 specifies that the results of the visual inspections of the steam dryer conducted during three scheduled refueling outages (beginning with the spring 2007 refueling outage) shall be reported to the NRC staff within 60 days following startup from the respective refueling outage. The license condition also states that the results of the SDMP shall be submitted to the NRC staff in a report within 60 days following the completion of all EPU power ascension testing. License Condition 7 specifies that the requirements for meeting the SDMP shall be implemented upon issuance of the EPU license amendment and shall continue until the completion of one full operating cycle at EPU conditions. If an unacceptable structural flaw (due to fatigue) is detected during the subsequent visual inspection of the steam dryer, the license condition states that the requirements for meeting the SDMP shall extend another full operating cycle until the visual inspection standard of no new flaws/flaw growth based on visual inspection is satisfied. License Condition 8 states that the license condition shall expire upon satisfaction of the requirements in License Conditions 5, 6, and 7 provided that a visual inspection of the steam dryer does not reveal any new unacceptable flaw or unacceptable flaw growth that is due to fatigue.

If BWRVIP-139 is approved prior to the period of extended operations, Entergy would convert to BWRVIP-139 guidelines from GE SIL 644. BWRVIP-139 provides detailed steam dryer information, including (1) discussion of steam dryer configurations for different plants, (2) summary of steam dryer operating experience, (3) discussion of

susceptibility for fatigue cracking and intergranular stress corrosion cracking, (4) discussion of failure modes and effects of cracking in steam dryer components, (5) discussion of relative stresses in different steam dryer components, (6) inspection recommendations for different steam dryer designs, (7) examples of evaluation approaches for steam dryer cracking, and (8) operational guidance for monitoring moisture carryover. If the NRC staff accepts BWRVIP-139, Entergy will be able to use the updated inspection guidelines in the BWRVIP document at Vermont Yankee.

4(c). (Hsu, Rowley) The staff finds the implementation of BWRVIP-139 acceptable because BWRVIP-139 will provide guidance for use of the latest methods and technology to manage steam dryer degradation during the period of extended operation. BWRVIP-139 will be continuously updated to incorporate newly acquired industry operating experience information and improved technology. In the case that BWRVIP-139 is not approved, the staff finds continued use of the SDMP acceptable. The SDMP incorporates the GE-SIL-644 which will include updated industry operating experience and technology. Either procedure will assure that Entergy will continue to inspect and monitor the steam dryer using the latest information and techniques available during the extended period of operation.

Q5. Describe the staff's review of Entergy's program for managing the effects of aging on the steam dryer.

A5(a). (Scarbrough) The NRC staff reviewed Entergy's SDMP as part of the evaluation of the EPU license amendment request for Vermont Yankee. The NRC obtained technical assistance from Argonne National Laboratory and its subcontractors in reviewing the structural improvements to the Vermont Yankee steam dryer, Entergy's analysis of the capability of the modified steam dryer to maintain its structural integrity

under EPU conditions, and the EPU power ascension testing program and long-term inspection and monitoring plan. The staff determined that Entergy had demonstrated that the stress on the modified steam dryer resulting from EPU operation at Vermont Yankee would remain below the fatigue stress limits specified in the ASME Code such that significant fatigue cracks are not expected to occur in the steam dryer during long-term EPU operation. The NRC staff documented the results of its review in the SE on the EPU license amendment request for Vermont Yankee attached to the license amendment dated March 2, 2006 (ML060050028) (Staff Exh. 14). The NRC staff monitored the EPU power ascension process at Vermont Yankee based on plant data provided by Entergy and through numerous interactions with Entergy personnel to confirm that plant performance was consistent with the steam dryer analysis presented by Entergy. The staff also reviewed the information obtained during the steam dryer inspection in spring 2007 to confirm that no significant fatigue cracking had occurred in the steam dryer during EPU operation.

A5(b). (Rowley, Hsu) As it relates to license renewal, the applicant stated that cracking due to flow-induced vibration in the stainless steel steam dryers is managed by the BWR Vessel Internals Program. The BWR Vessel Internals Program currently incorporates the guidance of GE-SIL-644, Revision 1. VYNPS will evaluate BWRVIP-139 once it is approved by the staff and either include its recommendations in the VYNPS BWR Vessel Internals Program or inform the staff of Entergy's exceptions to that document.

The staff finds the applicant's approach for managing cracking of steam dryers due to flow-induced vibration to be acceptable because the approach will be based on the guidelines developed by the ongoing activity of the BWRVIP. In addition, Entergy

has committed (SER Commitment No. 37) to continue inspections in accordance with the SDMP, Revision 3, in the event that BWRVIP-139 is not approved prior to the period of extended operation.

Q6. What did the staff conclude about Entergy's steam dryer aging management program?

A6a. (Scarbrough) As indicated in the SE on the Vermont Yankee EPU license amendment request, the NRC staff concluded that Entergy's program provided reasonable assurance that the flow-induced effects on the steam dryer were within the structural limits at then-CLTP conditions. The staff further concluded that Entergy had demonstrated that the steam dryer would continue to meet the requirements of the NRC regulations following implementation of the EPU at Vermont Yankee, subject to the license conditions specified in the EPU license amendment. The staff determined that the results of the EPU power ascension and the spring 2007 steam dryer inspection had confirmed the structural capability of the steam dryer for EPU operation.

A6(b). (Rowley, Hsu) To reach its conclusion in the SER for license renewal, the staff reviewed plant experience at numerous plants related to plant transients after extended power uprates and did not observe any abnormal behavior in the steam dryers.

On the basis of the operating experience and the EPU license conditions, the staff concluded that there is reasonable assurance that the VYNPS steam dryers will perform satisfactorily under EPU conditions during the proposed renewal period provided an adequate aging management program is used. The staff found the BWR Vessel Internals Program and the SDMP to be adequate methods to manage aging of the steam dryer. Also, if approved, BWRVIP-139 will be an adequate method to manage

aging of the steam dryer.

In addition, Vermont Yankee SER Commitment No. 51 (Staff Exh. 1) states that "Entergy will perform an evaluation of operating experience at EPU levels prior to the period of extended operation to ensure that operating experience at EPU levels is properly addressed by the aging management programs. The evaluation will include Vermont Yankee and other BWR plants operating at EPU level." This Commitment addresses the recommendation in Section 3.0.2 of the NUREG-1800 "Standard Review Plan for Review of License Renewal Application of Nuclear Power Plant" Rev. 1 (September 2005) (Staff Exh. 19) that license renewal applicants with approved EPUs commit to performing an operating experience review assessing the impact of the EPU on aging management programs for structures, systems, and components prior to the period of extended operation. Commitment No. 51 is therefore acceptable to the staff.

Q7. Does Entergy's steam dryer aging management program include continuous monitoring of plant parameters indicative of potential cracking by competent engineers?

A7. (Scarbrough, Hsu) Entergy's SDMP includes periodic monitoring of moisture carryover to identify degraded performance of the Vermont Yankee steam dryer in removing moisture from the steam exiting the reactor core. The SDMP also states that other reactor operational parameters that may be influenced by steam dryer integrity will be monitored with the intent of detecting structural degradation of the steam dryer during plant operation. For example, changes in the distribution of steam flow between individual steam lines can indicate degradation of the steam dryer. Entergy personnel will monitor plant data as part of their operational responsibilities. Based on interaction with Entergy personnel during the review of the EPU license amendment request and

monitoring of the EPU power ascension, the NRC staff considers Entergy personnel to be competent to obtain and evaluate plant data to identify potential steam dryer structural degradation.

Q8. How long does it take for crack to grow to a size such that it could result in the generation of loose parts?

A8. (Scarbrough) Operating experience at the Quad Cities nuclear power plant revealed that significant cracking of a steam dryer can occur within a few months if the fatigue stress limit for the material is exceeded by acoustic or hydraulic loading.

Q9. NEC asserts that cracks in the steam dryer grow quickly and thus a crack could develop between inspection and lead to the generation of loose parts. Do you agree? If not, do the initial indications of a crack take a number of cycles to even become an issue?

A9. (Scarbrough) It is agreed that cracks can grow quickly within a steam dryer if the fatigue stress limit for the material is exceeded. However, the strain gage data obtained during the EPU power ascension at Vermont Yankee indicated that the steam dryer loading did not result in stress in the steam dryer that exceeded the fatigue stress limit. Minor indications and cracking are typically identified during steam dryer inspections. These minor indications and cracking do not cause concerns for the generation of loose parts over the interval between steam dryer inspections.

Q10. Is Entergy's steam dryer aging management program sufficient to detect potential degradation of the steam dryer during operations?

A10. (Scarbrough) Yes. Moisture carryover and the monitoring of other plant parameters would reveal a significant degradation of the steam dryer if it occurred.

Q11. Are analytical tools required to interpret plant parameter data? If so, does

Entergy's program include such tools?

A11. (Scarbrough) Entergy used detailed analytical tools as part of the structural analysis to support the Vermont Yankee steam dryer capability for the EPU license amendment request and during the EPU power ascension. The monitoring of plant data, such as moisture carryover and steam flow mismatch, is part of the normal duties of plant personnel and does not require analytical tools of the complexity used as part of the steam dryer stress analysis to support the EPU license amendment. The steam dryer inspections during refueling outages are performed by experienced personnel using industry-accepted visual inspection techniques following GE-SIL-644 and BWRVIP-139 guidance documents.

Q12. What are the qualifications of the individuals who will analyze plant parameter data? Explain why those persons are competent?

A12. (Scarbrough) Vermont Yankee plant personnel are trained to monitor plant data for abnormalities through the reactor operator licensing process. If abnormalities are identified, detailed evaluations are performed by Entergy engineering staff. Based on its review of the EPU license amendment request and the EPU power ascension, the NRC staff considers Entergy to be capable of analyzing plant data related to steam dryer performance in an adequate manner.

Q13. Does Entergy's aging management program for the Vermont Yankee steam dryer include a method for estimating and predicting dryer stress loads? If yes, describe the method and opine on the reliability of the method. If not, explain why a method for estimating and predicting stress loads is not a necessary component of a steam dryer aging management program.

A13. (Scarbrough) Entergy's aging management program for the Vermont

Yankee steam dryer does not include a method for estimating and predicting dryer stress loads. Entergy performed detailed stress analyses of the Vermont Yankee steam dryer in support of the EPU license amendment request. During EPU power ascension, Entergy analyzed plant data to confirm that the pressure loads on the steam dryer during EPU operation do not result in stress that exceeds the fatigue limits in the ASME Code. With the determination that the pressure loads on the steam dryer during EPU operation are acceptable with the resulting stress below the fatigue limit, further stress analyses are not necessary for the Vermont Yankee steam dryer unless plant data or inspections indicate the need for additional detailed evaluations. Therefore, monitoring of plant data and periodic inspection of the steam dryer during refueling outages constitutes a reasonable approach for evaluating the aging of the steam dryer over the long term and determining whether more detailed analyses are necessary.

Q14. Has the staff reviewed and found adequate a stress load analysis for the steam dryer during the period of license renewal? If so, describe the analysis and explain why the staff found it adequate. If not, explain why a stress load analysis for the steam dryer during the license renewal period is unnecessary (in other words, why is a stress load analysis not a necessary component of a steam dryer aging management plan).

A14. (Scarbrough) Based on the EPU license amendment review and the EPU power ascension results, the NRC staff determined that the pressure loads during EPU operation will not result in stress on the Vermont Yankee steam dryer that exceeds the fatigue stress limit in the ASME Code. See Vermont Yankee Nuclear Power Station Report on the Results of Steam Dryer Monitoring, dated June 30, 2006, BVY 06-0560 (cover letter accession number ML061870276) (Staff Exh. 15). In that the pressure

loads are not expected to increase during long-term EPU operation, additional steam dryer stress analysis is not considered to be necessary unless plant data or steam dryer inspections indicate the need for more detailed evaluations.

Q15. Should Entergy's aging management program include some means for establishing dryer flow induced vibration load fatigue margins and demonstrating that the stresses on the dryer at selected locations will not exceed ASME fatigue limits? Explain why or why not.

A15. (Hsu) Entergy's aging management program does not need to include flow-induced vibration load fatigue margins because the Vermont Yankee steam dryer analysis performed in support of the EPU license amendment request and confirmed during the EPU power ascension demonstrated that the pressure loads during EPU operation do not result in stress on the steam dryer exceeding the fatigue stress limits in the ASME Code. As a result, the staff considers plant monitoring and periodic inspections of the steam dryer to be sufficient to indicate the need for any additional detailed steam dryer evaluations.

Q16. Does Entergy's aging management program rely solely on inspections and plant parameter monitoring *without* reliance on stress load analysis? If yes, explain why this is acceptable.

A16. (Scarbrough) Entergy's aging management program relies on steam dryer inspections and monitoring of plant parameters to determine whether more detailed evaluations (such as stress analysis) are necessary to provide continued confidence in the structural capability of the steam dryer for long-term EPU operation. Continuous stress analysis of the Vermont Yankee steam dryer is not necessary based on the results of the EPU power ascension program, which demonstrated that the pressure

loads during EPU operation do not result in stress on the steam dryer that exceeds the ASME fatigue stress limits.

Q17. Why did the staff conclude that Entergy's program to monitor and manage the effects of aging on Vermont Yankee's steam dryer is adequate to assure that the structural integrity of the steam dyer will be maintained during the period of extended operation?

A17. The NRC staff reviewed the steam dryer analyses performed by Entergy as part of the evaluation of the EPU license amendment request for Vermont Yankee. Based on its review, the staff concluded that Entergy had demonstrated that the Vermont Yankee steam dryer will maintain its structural capability during EPU operation. During the EPU power ascension at Vermont Yankee, the staff reviewed the plant data and analyses to confirm that the pressure loads during EPU operation did not result in stress on the steam dryer that exceeded the ASME fatigue stress limits. Further, the staff reviewed the results of the Vermont Yankee steam dryer inspection in spring 2007 to verify that no significant fatigue cracking occurred during EPU operation. With the recent EPU power ascension data and the steam dryer inspection confirming the structural capability of the Vermont Yankee steam dryer during EPU operation, the staff considers that monitoring of plant parameters and periodic steam dryer inspections are sufficient to provide reasonable assurance in the structural capability of the Vermont Yankee steam dryer over the long term. More detailed evaluations of the Vermont Yankee steam dryer, including stress analysis, can be performed if determined to be appropriate based on plant data and steam dryer inspection results.

Kaihwa R. Hsu
Statement of Professional Qualifications

CURRENT POSITION:

Senior Mechanical Engineer — Division of Engineering, Office of New Reactors, U.S. Nuclear Regulatory Commission, Rockville, MD

EDUCATION:

B.S., Chung Yuan Christian College, 1975, Civil Engineering
M.S., University of South Carolina, 1981, Civil Engineering in Structural Mechanics

SUMMARY:

Over 26 years of experience in the nuclear power industry, including 22 years as a principal engineer for Westinghouse Electrical Company. Significant experience in the following areas:

- Reactor Vessel, Steam generator, Pressurizer design & analyses
- Reactor Coolant Pump, Heat exchanger design & analyses
- Stress corrosion cracking, corrosion erosion
- Fracture mechanics evaluation
- Fatigue crack growth prediction and Flaw assessment
- Fatigue evaluation and leak before break demonstration
- ASME Code Section III and XI design analyses
- License Renewal aging management

EXPERIENCE:

U.S. Nuclear Regulatory Commission, 10/2003 - Present

6/2007 to Present – Senior Mechanical Engineer, Division of Engineering, Office of New Reactor

- Technical Reviewer for new reactor licenses in the area of engineering mechanics

10/2003 to 6/2007 - Materials Engineer, Division of License Renewal, Office of Nuclear Reactor Regulation

- Audit Team Leader for the license renewal safety audit at the Palisades, Harris, and Vermont Yankee Plants

- Backup Audit Team Leader for the license renewal safety audit at the Milestone Units 2 and 3, and Nine Mile Point Units 1 and 2

- Audit Team Member for the license renewal safety audit at the Oyster Creek, Wolf Creek, D.C. Cook, Arkansas Nuclear One - Unit 2 Plants

Westinghouse Electrical Co. 1981 – 2003

Principal Engineer the following divisions of Westinghouse

- **1998-2003, Structural Material Technology**
  - Primary water stress corrosion cracking (PWSCC) issue in reactor vessel (RV)
    - Performed all the analytical work which generated the proposed Westinghouse resolutions to plant specific problems in this area. The activities included:
      - RV CRDM/CEDM Penetration Alloy 600 Cracking & Penetration Weld Cracking
      - RV Nozzle Safe End Alloy 82/182 Butt Weld Cracking.
      - Structural Integrity Evaluation
      - Embedded Flaw Repair Technique and Procedure
      - Technical Justification for Continued Operation (JCO).
      - Alloy 82/182 Butt Weld Safety Assessment Report (EPRI MRP-44)
      - Participation in ASME Section XI Activities

- **February 1997- March 1998, Millstone Unit 3**: areas of work included
  - 10 CFR 50.54(f) program – Specific System Review
  - Resolution of Unresolved/Open Item
  - FSAR Review and Preparation of FSARCR
  - 10 CFR 50.59 Safety Evaluation for FSARCR

- **1993 – January 1997, Structural Material Technology**: areas of work included:
  - ASME Section XI Class 1 Component Finite Element Analysis.
  - Flaw Assessment per ASME Section XI
  - Inspection Procedure, Material Purchasing, and Scheduling of the steam generator replacement program
  - Pre-Operational Walk-down and Testing
  - Inspections during Refueling Outage
  - Fracture Mechanics and Structure Integrity
  - Piping Stress Qualification
  - Leak-Before-Break Demonstration
  - Fatigue Crack Growth Prediction
  - Time History Dynamic Analysis for AP600 Reactor Coolant Loop Piping
  - Steam Generator Tube Plugging
  - Transient Monitoring for Tech Specification Compliance

- **1990 – 1992, Piping Design and Qualification**: areas of work included:
  - Piping Stress Analysis
  - Equipment Qualification.
  - Thermal Stratification Analysis (IEB 88-08 and 88-11)
  - Fatigue Crack Growth Prediction
  - Computer Codes Development for the fatigue cycle monitoring system by using the Green function to perform stress and fatigue analysis
  - Nuclear Plant Records and Data Review to define operating transients

- **1988-1989, Structural Material Engineering**: areas of work included
  - Finite Element Analysis of PWR Component

- Piping Stress Analysis
- Fatigue Crack Growth Prediction
- Thermal Stratification Analysis (IEB 88-08 and 88-11)
- Computer Code Development for the Corrosion and Erosion Monitoring System to manage Flow Accelerated Corrosion issue

- **1983-1988, Piping Analysis and Design at Vogtle Plant Site**: areas of work included:
  - ASME Section III Piping Stress Analysis and Design
  - ANSI B31.1 Piping Stress Analysis and Design
  - Equipment Qualification
  - Instrument Tubing Design
  - Pre-Operational Walkdown and Testing

- **1981-1982, Stress Analysis at Westinghouse Tampa Division**: areas of work included:

  Equipment Qualification, Stress Analysis and Stress Report for Model F Steam Generator

Jonathan G. Rowley
Statement of Professional Qualifications

CURRENT POSITION:

Project Manager	Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Rockville, MD

EDUCATION:

B.S., Virginia Polytechnic Institute and State University, 1993, Materials Science and Engineering

M.S., University of Texas at Arlington, 2003, Materials Science and Engineering

SUMMARY:

Over 14 years of experience in materials science and engineering and over 3 years of experience in the nuclear reactor regulation. Significant experience in the following areas:

- Materials Engineering
- License Renewal

EXPERIENCE:

U.S. Nuclear Regulatory Commission, 08/03/2003 - Present

10/01/2006 to present – Project Manager, Division of License Renewal, Office of Nuclear Regulatory Research

- Lead Project Manager for the safety review of the Vermont Yankee Nuclear Power Station license renewal application

08/03/2003 to 10/01/2006 - General Engineer, Division of License Renewal, Office of Nuclear Regulatory Research

- Lead Project Manager for the safety review of the Donald C. Cook Nuclear Plant license renewal application

- Back-up Project Manager for the safety review of the R.E. Ginna license renewal application

Iowa Beef Processors. Assistant Laboratory Manager, 1993 – 2000:

Responsible for oversight of nine junior laboratory employees and day-to-day operations of the laboratory

Thomas G. Scarbrough
Statement of Professional Qualifications

CURRENT POSITION:

Senior Mechanical Engineer
Component Integrity, Performance, and Testing Branch II (CIB2)
Division of Engineering (DE)
Office of New Reactors (NRO)
U.S. Nuclear Regulatory Commission (NRC)
Rockville, MD

EDUCATION:

Bachelor of Arts in Physics, Rollins College, 1976

Bachelor of Nuclear Engineering, Georgia Institute of Technology, 1977

Master of Science in Mechanical Engineering, University of Maryland, 1988

PROFESSIONAL:

Registered Professional Engineer (Maryland #14453))

Member of American Nuclear Society

Member of American Society of Mechanical Engineers (ASME) Subcommittee on Qualification of Valve Subassemblies for the ASME QME-1 Standard, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants"

Previous member of ASME Subgroup on Motor-Operated Valves for the ASME *Code for Operation and Maintenance of Nuclear Power Plants*

SUMMARY:

I have over 30 years of technical experience in the field of nuclear engineering. In 1977, I began my career as an associate engineer at the Naval Reactor Facility in Idaho Falls, ID. In 1978, I joined the NRC and served in the Office of Standards Development and subsequently the Office of Nuclear Regulatory Research. In 1981, I was appointed as Special Technical Advisor to the Atomic Safety and Licensing Appeal Panel (ASLAP) for the restart of the Three Mile Island (TMI) Unit 1 nuclear power plant and, later, was appointed as Technical Advisor to the ASLAP. In 1989, I transferred to the Mechanical Engineering Branch in the NRC Office of Nuclear Reactor Regulation (NRR), and was assigned as principal engineer for the NRC staff review of the implementation of Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." In that assignment, I participated in numerous reviews and inspections of motor-operated valve (MOV) programs at operating nuclear power plants. Following the failure of the steam dryer at Quad Cities Unit 2 in 2002, I was assigned to participate in the review of potential adverse flow effects on plant components during power uprate operation. Since then, I have participated in the review of the power uprate requests for the Vermont Yankee, Browns Ferry, Hope Creek, Susquehanna, and other nuclear power plants

with regard to potential adverse flow effects. In February 2007, I was assigned to the Component Integrity, Performance, and Testing Branch II in the NRC Office of New Reactors where I review component issues for proposed new reactors, and provide assistance to NRR on potential adverse flow effects for power uprates at operating nuclear power plants.

EXPERIENCE:

Senior Mechanical Engineer, NRC/NRO/DE/CIB2, February 2007 to Present

In February 2007, I was assigned to the Component Integrity, Performance, and Testing Branch II in the Division of Engineering of the NRC Office of New Reactors. In this position, I am responsible for the review of the functional design, qualification, and inservice testing (IST) programs for pumps and valves that will perform safety functions in new reactor designs to be certified and new reactors to be licensed under the NRC regulations. In addition, I review potential adverse flow effects for new reactor designs and proposed reactors that might affect pumps, valves, and other plant equipment (including steam dryers in boiling water reactors). I have assisted in the revision of the NRC Standard Review Plan and Regulatory Guide 1.20 to incorporate lessons learned from adverse flow effects on plant equipment for the review of new reactor design certifications, operating licenses, and power uprates. In providing assistance to the NRC Office of Nuclear Reactor Regulation, I participated in the review of potential adverse flow effects for the recent power uprates at the Hope Creek and Susquehanna nuclear power plants.

Senior Mechanical Engineer, NRC/NRR/Division of Engineering and Division of Component Integrity, June 1989 to February 2007

In June 1989, I joined the Mechanical Engineering Branch in NRR/DE and was assigned as principal engineer for the review of MOV performance issues at nuclear power plants. In this assignment, I coordinated the NRC staff review of the implementation of GL 89-10 at operating nuclear power plants. In addition to several supplements to GL 89-10, I was the principal contributor for GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves." I reviewed submittals from nuclear power plant licensees in response to these generic letters and participated in NRC inspections of MOV programs at nuclear power plants. I have represented the NRC staff at numerous public meetings and conferences to discuss MOV performance issues. Following the failure of the steam dryer at Quad Cities Unit 2 in 2002, I was assigned to participate in the NRC staff review of potential adverse flow effects at nuclear power plants operating at extended power uprate (EPU) conditions or requesting power uprate operation. In that assignment, I was a principal technical reviewer for the NRC staff's evaluation of the acoustic resonance issue at Quad Cities with participation at technical meetings at the NRC offices, licensee's offices, steam dryer manufacturing facility, steam dryer assembly facility, and licensee contractor's small scale test facility. I have worked closely with the NRC contractors from Argonne National Laboratory and its subcontractors from Pennsylvania State University and McMaster University in evaluating potential adverse flow effects at nuclear power plants. In response to the EPU license amendment request by the licensee of the Vermont Yankee nuclear power plant, I served as a principal technical reviewer of potential adverse flow effects on plant equipment, including the steam dryer. In this assignment, I participated in the review of information provided by the Vermont Yankee licensee in support of the EPU request as well as the results of technical evaluations performed by NRC contractors. In addition, I led an NRC staff audit of the initial steam dryer analysis for Vermont Yankee in 2004 at the General Electric (GE) offices and the GE small scale test facility in Palo Alto, CA. I also participated in meetings with the Vermont Yankee licensee and assisted in

NRC staff audits of technical documentation of the Vermont Yankee steam dryer analysis. I was a principal contributor for the documentation of the NRC staff review of potential adverse flow effects, and pumps and valves, in the NRC safety evaluation on the EPU license amendment for Vermont Yankee. Before the Advisory Committee on Reactor Safeguards, I coordinated the discussion by the NRC staff and its contractors of the results of the NRC staff review of potential adverse flow effects for the Vermont Yankee EPU license amendment. Following issuance of the Vermont Yankee EPU license amendment on March 2, 2006, I participated in the NRC staff review of plant data from Vermont Yankee during power ascension up to EPU conditions. With the reorganization of NRR in 2005, I was transferred into the Component Performance and Testing Branch in the new Division of Component Integrity with the same technical assignments.

Technical Advisor, Atomic Safety and Licensing Appeal Panel, 1981 to 1989

In 1981, I was appointed as Special Technical Advisor for the restart of the TMI Unit 1 nuclear power plant for the Atomic Safety and Licensing Appeal Panel. In this position, I reviewed technical information provided by the TMI licensee and NRC staff to assist the administrative judges of the ASLAP in the review of the Atomic Safety and Licensing Board decision on the restart of TMI Unit 1. Subsequently, I was appointed as Technical Advisor to the ASLAP. In that assignment, I provided assistance to the ASLAP administrative judges on a wide variety of nuclear engineering issues.

Mechanical Engineer, NRC Offices of Standards Development and Nuclear Regulatory Research, 1978 to 1981

In 1978, I joined the NRC in the Office of Standards Development where I participated in the development and revision of NRC regulatory guides related to mechanical engineering activities at nuclear power plants. The Office of Standards Development was subsequently incorporated into the NRC Office of Nuclear Regulatory Research.

Associate Engineer, Naval Reactor Facility, Idaho Falls, ID, 1977 to 1978

At the Naval Reactor Facility, I participated in a program to develop nuclear power engineers to assist in the training of Navy personnel in the design, operation, and maintenance of nuclear reactors.

ROTATIONAL ASSIGNMENTS AND TRAINING:

I have performed rotational assignments in the NRC Region I office in King of Prussia, PA (on two occasions) and NRC Region II office in Atlanta, GA, in section chief management positions in the reactor safety division. In addition, I assisted the NRC resident inspectors during preparation for the startup of the Comanche Peak Unit 2 nuclear power plant. I have completed numerous training opportunities at the NRC including MOV design and operation, pump design, pressurized and boiling water reactor systems, safety relief valve operation, NRC inspector performance, and radiation protection.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF KAIHWA R. HSU

I, Kaihwa R. Hsu, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Kaihwa R. Hsu
KAIHWA R. HSU

Executed at Rockville, MD
this 13th day of May, 2008

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	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF JONATHAN G. ROWLEY

I, Jonathan G. Rowley, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Jonathan Rowley
JONATHAN G. ROWLEY

Executed at Rockville, MD
this 13th day of May, 2008

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	)	
(Vermont Yankee Nuclear Power Station)	)	

AFFIDAVIT OF THOMAS G. SCARBROUGH

I, THOMAS G. SCARBROUGH, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Thomas G. Scarbrough
THOMAS G. SCARBROUGH

Executed at Rockville, MD
this 13th day of May, 2008