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 AND JONATHAN G ROWLEY
CONCERNING NEC CONTENTION 4 (FLOW-ACCELERATED CORROSION)

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

A(a). My name is Kaihwa R. Hsu ("Hsu").[1] I am employed by the NRC as a senior mechanical engineer in the Engineering Division 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 to my affidavit concerning NEC Contention 3 (Staff Exh. 4).

A(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 to my affidavit concerning NEC Contention 3 (Staff Exh. 4).

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," "Licensee," or "Vermont Yankee").

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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 both witnesses.

A(a). (Hsu) In connection with the Staff's review of the LRA, I was as an Audit Team Member for the license renewal safety audit at Vermont Yankee, and I served as a 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.

A(b). (Rowley) In connection with the Staff's review of the LRA I am the lead project manager ("PM") for the Staff's safety review of the Vermont Yankee license renewal application. As the PM, I am the principal point of contact in NRR for activities related to the Vermont Yankee license 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 (SER) (Staff Exh. 1), which was issued to the public in February 2008.

Q3. What is the purpose of your testimony?

A3. The purpose of this testimony is to present the staff's position regarding NEC Contention 4 (Flow-Accelerated Corrosion). As admitted by the Board, LBP-06-20, 64 NRC 131, 192-96 (2006), NEC's contention alleges that "Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of plant piping due to flow-accelerated corrosion during the period of extended operation." We

have read relevant portions of: LPB-06-20, 64 NRC 131 (2006) (admitting NEC Contention 4); 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 4 (Flow Accelerated Corrosion) (June 5, 2007); NEC's "Opposition to Entergy's Motion for Summary Disposition of NEC's Contention 4 (Flow-Accelerated Corrosion) (July 16, 2007); and "Memorandum and Order (Ruling on Motion for Summary Disposition of NEC Contention 4)" (August 10, 2007) (unpublished).

Q4. What is flow-accelerated corrosion?

A4. (Hsu) Flow-accelerated corrosion is also known as erosion-corrosion. It is corrosive attack accelerated by high velocity flow, either washing away otherwise protective films or mechanically disturbing the metal itself.

Q5. Describe Entergy's program to monitor and manage the aging of plant piping at Vermont Yankee due to flow-accelerated corrosion (FAC).

A5. Implemented in accordance with the EPRI guidelines, Vermont Yankee's FAC program predicts, detects, and monitors FAC in plant piping and other pressure retaining components. The program includes (a) an evaluation to determine critical locations, (b) baseline inspections to determine the extent of thinning at these locations, (c) follow-up inspections to confirm the predictions, or repairing or replacing components. SER Section 3.0.3.1.2 (Staff Exh. 1). The program also includes expansion of the scope when significant wall thinning is discovered in a component.

Q6. Describe how Vermont Yankee selects piping components for UT inspection?

A6. The criteria for selecting components for inspection are described in VY program procedure PP7028 as identified in letter BVY 04-008 (January 31, 2004)

(ML040480640) (Staff Exh. 17). The criteria for selecting specific components for examination during a refueling outage include (1) CHECWORKS predictive models, (2) components identified during previous inspections, (3) industry experience, (4) susceptible piping not modeled by CHECWORKS, and (5) plant specific experience and engineering judgment.

Q7. Describe how Vermont Yankee plans to use CHECWORKS as an aging management tool.

A7. (Hsu) Vermont Yankee uses CHECWORKS as a tool for selecting components for inspection during a refueling outage. For piping without inspection data, CHECWORKS is used to select the most susceptible components on a line or section of piping for inspection. For piping with previous inspection data, CHECWORKS is used to select the components that have the highest wear rate and lowest failure time for inspection.

Q8. Describe the Staff's review of Vermont Yankee's program

A8. The Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (SRP-LR) provides guidance to NRC staff reviewers. The Staff perform safety reviews of aging manage programs in accordance with 10 C.F.R. Part 54. In a Staff paper (SECY 99-148), "'Credit for Existing Programs for License renewal," dated June 3, 1999 (Staff Exh. 18), the Staff described options and provided a recommendation for crediting existing program to improve the efficiency of the license renewal process. In a Staff Requirements Memorandum (SRM) dated August 27, 1999, the Commission approved the Staff's recommendation and directed the Staff to focus the review guidance in the SRP-LR on areas where existing programs should be augmented for license renewal. Under the terms of the SRM, the SRP-LR would

reference a "Generic Aging Lessons Learned" (GALL) report, which evaluate existing program generically, to document (1) the conditions under which existing program are considered adequate to manage identified aging effects without change and (2) the conditions under which existing programs should be augmented for this purpose. The GALL Report (NUREG-1801) has been treated as an approved topical report. Vermont Yankee's FAC program is an existing program. The staff assessed ten program elements (scope, preventive actions, parameters to be monitored or inspected, detecting of aging effects, monitoring and trending, acceptance criteria, corrective actions, conformation process, administrative controls, and operating experience) to verify their technical adequacy.

By letter dated March 2, 2006 (ADAMS accession number ML060050024) (Staff Exh. 14), the NRC granted Vermont Yankee a 20% extended power uprate (EPU). This can affect aging management. NUREG-1800 "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" Rev. 1 (September 2005) ("SRP") (Staff Exh. 19) Section 3.0.2 states that, "All LRAs with an approved EPU will be required to perform an operating experience review and its impact on aging management programs for structures, and components before entering the period of extended operation." That section of the SRP further provides: "One way for an applicant with an approved EPU to satisfy this criterion is to document its commitment to perform an operating experience review and its impact on aging management programs for systems, structures, and components (SSCs) before entering the period of extended operation as part of its license renewal application." 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 SRP's recommendation and is therefore acceptable to the Staff.

In the safety evaluation of the EPU (ML060050028)(Staff Exh. 14), the staff reviewed Vermont Yankee's evaluation of the effect of the proposed EPU on the FAC analysis for the plant and concluded that the applicant adequately addressed the effect of changes in plant operating conditions on the FAC analysis.

Q9. What did the Staff conclude about Vermont Yankee's FAC aging management program?

A9. The program will predict the loss of material by FAC and will ensure timely repair or replacement of degraded components. The staff concludes that Entergy has demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation. SER Section 3.0.3.1.2 (Staff Exh. 1)

Q10. Describe your knowledge of CHECWORKS?

A10. (Hsu) During my previous employment at Westinghouse, I was assigned to develop computer code, Corrosion Erosion Monitoring System (CEMS), to manage FAC for nuclear power plants. I accumulated my knowledge of CHECWORKS through audit and self-study. CHECWORKS software helps identify what piping is most susceptible to FAC. CHECWORKS is a way to set priorities to mitigate FAC related damage in advance of failure. CHECWORKS was developed and benchmarked by using data from many plants. CHECWORKS is used to select the most susceptible components for inspection and calculate wear rates to predict when the component will

reach the minimum allowable thickness. Follow-up inspections are used to confirm the predictions.

Q11. Describe CHECWORKS.

A11. (Hsu) CHECWORKS was developed and benchmarked using data from many plants. CHECWORKS is a tool used to select the most susceptible components for inspection and calculate wear rates to predict when the components will reach the minimum allowable thickness. Follow-up inspections throughout the life of the plant are used to confirm the predictions. Plants using CHECWORKS must input plant specific operating parameters to effectively use CHECWORKS to perform component susceptibility rankings. Once data from inspections is entered into CHECWORKS, which determines the actual wear rate and recalibrates itself, the predicted wear rates and thickness values are adjusted to reflect the actual wear from the inspection data. In other words, wear rates and wear rate predictions are based on actual inspection data.

Q12. What is "benchmarking"? What does "benchmarking" mean?

A12. (Hsu) Benchmarking is a comparison of non-established results with established/recognized results. The CHECWORKS model has to be calibrated with data from inspections to calculate actual wear and the line correction factor. The line correction factor in CHECWORKS is used to adjust wear rate predictions in a given line to account for plant operating conditions that may vary with time. It is determined by comparing predicted wear to measured wear at locations in the line which have been inspected. The so-called benchmarking is really the continuous recalibration process.

Vermont Yankee will continually use the model to identify areas to inspect and feed data into CHECWORKS. It's an ongoing cycle, a living program. However, CHECWORKS is a tool to set priority to mitigate FAC related damage in advance of

failure. NEC's experts consider recalibration as benchmarking. In reality, CHECWORKS still cannot determine the absolute wear with many recalibrations since corrosion is not an exact science due to epistemic and aleatory uncertainty which cannot be eliminated.

Q13. What is "calibrating"?

A13. (Hsu) Calibrating means to input plant-specific data into the CHECWORKS program in order to model FAC at the plant and to predict and rank FAC susceptible locations.

Q14. GALL Section XI.M17 (Staff Exh. 7) states: "CHECWORKS was developed and benchmarked by using data obtained from many plants." Explain what "benchmarking" means as used in GALL Section XI.M17.

A14. (Hsu) CHECWORKS was developed to model how FAC wear rates are affected by the alloy composition, fluid pH level, control amine, hydrazine concentration, dissolved oxygen, fluid velocity, component geometry, upstream influences, fluid temperature, and steam quality. CHECKWORKS is an empirical model, meaning that the CHECWORKS model for wear rate predictions was developed using the data from many plants and laboratory experiments. CHECWORKS was "benchmarked" by comparison to the CHECWORKS models' predicted susceptible locations with actual wear data obtained from nuclear power plants and additional laboratory data. This comparison showed that the CHECWORKS model accurately predicts FAC behavior. No further "benchmarking" of CHECWORKS is needed. All that is needed is calibration of CHECWORKS to model plant-specific conditions.

Q15. If CHECWORKS was developed and benchmarked using data obtained from many plants, explain why a plant would need to "benchmark" CHECWORKS using

plant specific data. If it's not necessary to benchmark using plant specific data, explain why.

A15. (Hsu) The CHECWORKS program has been benchmarked. To model and predict FAC at a given plant, the user must calibrate the CHECWORKS program to plant specific conditions by inputting plant parameters into the program. There is, however, no way to predict wear with absolute certainty due to epistemic and aleatory uncertainty. Corrosion is not an exact science. It depends on many small, unique, local variables. It is not like manufacturing widgets, where if you use the same amount of material produced in the same way, you end up with identical widgets. In a typical nuclear plant, there may be 5,000 susceptible components, but the plant may only be able to inspect less than a hundred during an outage. CHECWORKS helps identify which piping is most susceptible to FAC and helps set inspection priorities. This is the reason that FAC program is continued throughout plant life.

Q16. NEC's expert(s) have asserted that CHECWORKS requires continuous "benchmarking." Are NEC's experts correct? Explain.

A16. (Hsu) No, there is no way to get absolute wear rates even with continuous benchmarking or years of calibration. The most important part in using CHECWORKS is evaluating what the model is telling and applying engineering judgment (which is informed by plant operating experience, industry experience, and NRC generic communications) to select appropriate inspection locations. NEC expert's intention is to try to use continuous recalibrations to get absolute wear. However, Vermont Yankee will continuously use CHECWORKS as a tool and will continuously input data from inspections into the CHECWORKS database throughout plant life. This action could meet NEC expert's intent of continuous benchmarking.

Q17. NEC asserts that plant specific data needed to calibrate or recalibrate the CHECKWORKS model? Is NEC correct? Explain.

A17. (Hsu) Yes, plant specific data is needed to calibrate the CHECWORKS model. For example, water chemistry improvement will reduce corrosion; piping material has been replaced with FAC-resistant material, etc. Related plant data has to be entered into CHECWORKS model to reflect the actual plant conditions.

Q18. Is plant specific data needed in order to use CHECWORKS as part of a program to manage flow-accelerated corrosion? Explain why or why not.

A18. (Hsu) Plant specific data is needed to use CHECWORKS appropriately for susceptible ranking purposes. The CHECWORKS model's empirical wear rate predictions require input plant specific operating parameters. However, once actual inspection data is included in the CHECWORKS model, the predicted wear rates and thickness values are statistically factored to reflect the actual wear from the inspection data.

Q19. If plant specific data is needed to use (i.e. calibrate) CHECWORKS, how many cycles? If not, explain why.

A19. (Hsu) It requires a minimum of two cycles of inspection data to obtain actual wear for a component. The data from those inspections is entered into CHECWORKS, which determines the actual wear and recalibrates itself. However, the FAC program is continued throughout plant life and inspection data is continually entered into CHECWORKS as part of an ongoing cycle, making CHECWORKS a living program. To use CHECWORKS effectively the user must evaluate what the model is telling him or her and apply engineering judgment informed by plant-specific and industry operating experience, including NRC generic communications, to select appropriate

inspection locations. Follow-up inspections are used to confirm the wear prediction.

NEC referenced as industry guidance, Chockie Group International, "Aging Management and Life Extension in the US Nuclear Industry" (October 2006) (Exh. NEC-UW_13 at 38) in support their assertion that 5-10 years data trending is necessary. The referenced industry guidance, however, quotes the development of the Preventive Maintenance Basis Program (PM basis) by EPRI for a plant's equipment performance and reliability. The guidance states that:

> In order to establish a baseline for the plant's equipment performance and reliability, the operating history over the last 5 to 10 years is reviewed and trended. Typically, the plant will have a work order database from which the preventive and corrective work orders can be accessed. A simple count per year will provide a meaningful trend to see if maintenance activities are increasing, decreasing or portray a stable trend. Also, the ratio of preventive to corrective work orders will provide some indication for a successful maintenance program (corrective work orders are decreasing), or the trend will point to problems, that is failures are increasing as an indication of progressive aging problems.

According to the guidance referenced by NEC, the 5 to 10 year recommendation is for preventive maintenance programs to count the number of work orders for major equipment maintenance improvement as an additional program which is not addressed by the GALL Report. The GALL Report does not consider regular/routine maintenance to be an age-related issue. Therefore there is no requirement to consider regular maintenance activities as aging management programs. This NEC-referenced industry guidance credits the GALL Report (NUREG-1801) and the SRP (NUREG-1800) for the existing programs, such as FAC program and does not suggest additional limitations as NEC claims.

Q20. Is additional plant-specific data necessary in order to recalibrate CHECWORKS following a significant change in plant parameters such as an EPU? If so, how many cycles of data are needed and why? If not, explain why. .

A20. (Hsu) As stated above, two cycles of inspection data are usually needed to recalibrate CHECWORKS following a change in plant parameters. Instead of entering inspection data into CHECWORKS, it is also acceptable to enter inspection data into a spreadsheet program for purposes of trending/predicting FAC. However, in the case of Vermont Yankee, only one cycle of inspection results is needed for trending. Section 2.1.6 of Safety Evaluation Report for Vermont Yankee's Extended Power Uprate (ML060050028) (Staff Exhibit 14) stated that "The licensee has determined that an increase in the velocities in the main steam line and feedwater lines will cause proportional increases in FAC wear rates." The staff agreed with Vermont Yankee's determination in its SER for the EPU. At the June 5, 2007, ACRS subcommittee meeting to discuss the LRA, Vermont Yankee officials reported that they had completed 63 inspections and the results were satisfactory. Exh. NEC-UW_11 at 43. In fact, the results were consistent with analytical predictions that Vermont Yankee used in its modeling for FAC. Thus, Vermont Yankee only needs one cycle of inspection results to confirm FAC wear rates for the EPU period if previous inspection data has established a baseline (but two more inspections will be completed prior to the period of extended operation and inspections will continue throughout the period of extended operation). Inspection data beyond what is needed to recalibrate CHECWORKS can be used to further confirm FAC wear rate.

Q21.. Is 7-15 years worth of plant-specific data necessary before CHECWORKS can be used reliably to recalibrate CHECWORKS to EPU conditions?

A21. (Hsu) No, it is not necessary to have 7-15 years plant-specific data to ensure that CHECWORKS can be used reliably. Currently, there are a lot of utilities with EPUs (Clinton 20% EPU, Dresden Units 2 & 3 17% EPU, and Quad Cities Units 1 & 2

17.8% EPU) that do not have 7-15 years of data. The answer above addressed the industry guidance referenced by NEC--Chockie Group International, "Aging Management and Life Extension in the US Nuclear Industry" (October 2006) (Exh. NEC-UW_13 at 38). That guidance does not suggest 7-15 years of FAC data is needed.

Q22. Can CHECWORKS be used effectively at Vermont Yankee during the period of extended operations?

A22. (Hsu) Yes, CHECWORKS can be used effectively at VY during the period of extended operation. Vermont Yankee will continue its FAC aging management program to perform additional inspections using CHECWORKS throughout the life of the plant There are a lot of utilities with approved EPUs successfully using CHECWORKS, including, Clinton 20% EPU, Dresden Units 2 & 3 17% EPU, and Quad Cities Units 1 & 2 17.8% EPU.

Q23. Explain why Vermont Yankee can use CHECWORKS under EPU conditions if the plants supplying data for CHECKWORKS have not increased power by 20%.

A23. (Hsu) CHECWORKS was developed independent of power levels. To use CHECWORKS, the user must accurately input plant parameters. Vermont Yankee increased its output by 20%, from 1592 MWt to 1911 MWt. Dresden Units 2 & 3 increased their output by 17%, from 2527 MWt to 2957 MWt. Quad Cities Units 1 & 2 increased their output by 17.8%, from 2511 MWt to 2957 MWt. Clinton increased its output by 20%, from 2897 MWt to 3457 MWt. The original power levels for all of those plants were much greater than Vermont Yankees, and thus, their extended power uprate outputs are much greater than that of Vermont Yankee. All of these plant use CHECWORKS.

Q24. NEC claims that as a result of Vermont Yankee's EPU, which increased flow velocity, new locations of high corrosion are likely to develop that CHECWORKS as calibrated to pre-EPU conditions will be unable to predict. Is this correct?

A24. (Hsu) No, the most important part in using CHECWORKS is evaluating the information provided by the model and applying engineering judgment to select appropriate inspection locations. Vermont Yankee has addressed the impact of the EPU on FAC in the feedwater and steam related systems. Vermont Yankee addressed the impact of the EPU on plant components as stated in the letter BVY 04-008 Attachment 2 (ML040480640) (Staff Exh. 17). In addition, Section 2.1.6 of Safety Evaluation Report for Vermont Yankee's EPU (ML053010167) (Staff Exh. 14) stated that "The licensee has determined that an increase in the velocities in the main steamline and feedwater lines will cause proportional increase in FAC wear rate." Vermont Yankee multiples the velocity increase by the pre--EPU wear rate to get an EPU wear rate. Vermont Yankee has now performed inspection(s) to confirm FAC ware rates for EPU period. The inspections confirmed Vermont Yankee's predictions. Exhibit NEC-UW_11 at 43. Any additional inspection data can be used to further confirm FAC wear rate.

Q25. NEC claims that calibration of CHECWORKS is difficult because FAC is highly localized, may not be linear with time, and results from the interaction of many complex variables. Is this correct?

A25. (Hsu) Corrosion is not an exact science due to epistemic and aleatory uncertainty which cannot be eliminated. CHECWORKS is a tool to help identify which piping is most susceptible to FAC, monitor FAC, and mitigate FAC in advance of failure instead. CHECWORKS is not for calculating absolute values of actual wear. It is very difficult to calculate absolute wear and predict accurately. The purpose of this software

is to provide reasonable assurance that structural integrity will be maintained between inspections.

Q26. Is using data from other plants sufficient to predict FAC at Vermont Yankee under EPU conditions? Why or why not.

A26. (Hsu) Vermont Yankee increased its power level by 20% from 1592 MWt to 1911 MWt, an increase of 319 MWts. While other plants have increased power by less than 20%, the increases in MWts produced are much greater because their original power levels were much greater. Dresden Units 2 & 3 increased power by 17% from 2527 MWt to 2957 MWt for an increase of 430 MWts. Quad Cities Units 1 & 2 increased power by 17.8% from 2511 MWt to 2957 MWt for an increase of 446 MWts. Clinton increased power by 20% from 2897 MWt to 3457 MWt for an increase of 560 MWts. The empirical wear formulation from these and other plants has been incorporated into CHECWORKS. It is therefore acceptable for VY to use CHECWORKS to for ranking FAC susceptible locations at EPU conditions while keeping in mind, that once inspections have been performed and the results entered into CHECWORKS, CHECWORKS uses plant-specific inspection data and wear rates for its predictions.

Q27. Does CHECWORKS need to be continuously updated with plant-specific inspection data in order to effectively predict pipe wall thinning?

A27. (Hsu) As previously stated, only two cycles of inspection results are needed to use CHECWORKS to predict pipe-wall thinning. However, Vermont Yankee plans to continue to inspecting FAC-susceptible piping and inputting the results into CHECWORKS for the life of the plant. The CHECWORKS model must be updated to reflect current plant-specific operating parameters order to effectively predict FAC behavior. The CHECWORKS program (i.e. the software), like other commercial

software, is periodically upgraded based on data supplied by the CHECWORKS users group and improvements in computer and imaging technology.

Q28. Would additional cycles of plant-specific inspection data be useful to calibrate/recalibrate CHECWORKS? If yes, explain how the data would be helpful.

A28. (Hsu) Additional inspection data is useful to confirm the predictions and/or to confirm the need to necessary repair or replace components. Additional inspection data, however, would not be useful to recalibrate the program in an effort to determine absolute wear rates.

Q29. Has CHECWORKS been shown to handle large changes in plant parameters?

A29. (Hus) Yes, currently CHECWORKS is used successfully at Clinton (20% EPU (579 MWT)), Dresden Units 2 & 3 (17% EPU (430 MWT)), Quad Cities Units 1&2 (17.8% EPU (446 MWT)), and Vermont Yankee (20% EPU (319 MWT)).

Q30. Is CHECWORKS an effective tool to monitor and managing the aging effects of FAC?

A30. (Hsu) Yes, CHECWORKS is being used successfully by all US nuclear utilities, many US fossil plants, and utilities overseas. It is important to keep in mind CHECWORKS just a tool to help the user selected FAC-susceptible locations for inspection and monitoring. It provides reasonable assurance that structurally integrity will be maintained between inspections, not that FAC will not occur or that repairs, including costly ones, will never be needed.

Q31. Does CHECWORKS need to be modified to as a plant ages?

A31. (Hus) No, but the FAC aging management program is continued throughout the plant's life.

Q32. Do FAC incidents at other nuclear power plants call into question the predictive capability of CHECWORKS?

A32. (Hsu) CHECWORKS has to use actual wear from inspection(s) to perform its trend/predictions. In his first declaration (Exhibit 7 to NEC's May 26, 2006 Petition to Intervene), Dr. Hopenfeld listed FAC incidents at other nuclear plants. In paragraph 26 of that declaration Dr. Hopenfeld states that:

> "This list alone, however, is sufficient to demonstrate that CHECWORKS (developed in 1987) has not been successful in averting major catastrophes and costly outages."

The statement is not accurate. (1) The 1986, feedwater pipe elbow rupture at Surry occurred before CHECWORKS was developed and therefore does not demonstrate that CHECKWORKS has been unsuccessful in averting problems. (2) The 1990 and 1993, feedwater ring and J-tube ruptures in San Onofre's steam generators do not demonstrate that CHECWORKS has not been successful in identifying FAC. As stated in NRC Information Notice 91-19 (IN 91-19) (Staff Exh. 20), the issue was identified during a routine outage inspection. Following the incident, the steam generator vendor, Combustion Engineering, issued an information bulletin recommending that its client utilities perform a baseline inspection during their refueling outage to detect wall thinning in the feedwater distribution system. There were no established base line inspections for the feedwater ring and the J-tubes in San Onofre's steam generator at the time of the events. Therefore, there was no actual wear data for CHECWORKS to trend/predict. Furthermore, the feedwater ring and J-tubes are located inside of steam generator and are managed by a plant's steam generator integrity program not its FAC program. Thus there is no way to justify the incidents as a failure of CHECWORKS. (3) The 1997

extraction steam piping ruptured at the Fort Calhoun Station was not a failure of CHECWORKS. As discussed in NRC Information Notice 97-84 (Exh. NEC-JH_51), the cause of this FAC incident was incorrect operating data inputs, length of component service time, and line correction factor. One of the inputs in CHECKWORKS is the length of component service time. The actual wear occurred over the 2 years the component was actually in service rather than presumed 14 years in the CHECWORKS model. Therefore, the calculated line correction factor was biased and thus under-predicted the wear rates, resulting in the unpredicted pipe failure. This failure was the result of an input error and therefore does not evidence a failure of CHECWORKS to perform its trending/prediction function. (4) The 2004, condensate system piping ruptured at the Mihama-3 was not a failure of CHECWORKS since Mihama did not use EPRI Guidelines or CHECWORKS. As discussed in NRC Information Notice 2006-08 (Staff Exh. 21), FAC is managed differently in Japan than in the US, where most licensees manage FAC by implementing the EPRI Guidelines described in NSCA-202L.

In short, these four events do no demonstrate the CHECWORKS has not been successful in managing FAC.

Q33. Has Vermont Yankee ever had an FAC-related pipe rupture?

A33. (Rowley) The Staff has no record of a FAC-related pipe rupture in the 3rd quarter of 2006 as NEC has stated. There is a record of a small leak in a six inch piping segment of the low pressure turbine gland seal, which was replaced in the spring outage of 2007.

Q34. For purposes of license renewal, is it sufficient for Entergy to "generally know" the piping locations at Vermont Yankee most susceptible to FAC?

A34. (Hsu) Yes, the detailed discussion can be found in BVY 04-008

Attachment 2 (ML040480640) (Staff Exh. 17). In Attachment 2 to BVY-04008, Vermont Yankee provided detailed discussion for those piping lines and systems where predicted wear rates would change due to changes in temperatures and velocities after EPU. The staff evaluated Vermont Yankee's FAC program after EPU and determined it acceptable.

Q35. Could FAC-susceptible locations develop without the ability of CHECWORKS to rank those locations?

A35. (Hsu) There are miles of piping in nuclear plants, making it impossible to inspect all of it. CHECWORKS helps identify which piping is most susceptible to FAC and is a way to set priorities. As described in BVY 04-008 Appendix E (ML040480640) (Staff Exh. 17), the criteria for selecting of specific components for examination during a refueling outage include (1) CHECWORKS Predictive Models (2) Components Identified during previous inspections (3) Industry Experience Components (4) Susceptible piping not modeled by CHECWORKS (5) Plant specific experience and Engineering Judgment. The program also includes expansion of the scope when significant wall thinning is discovered in a component. CHECWORKS is not the only option for selection FAC-susceptible locations. Vermont Yankee is not relying solely on CHECWORKS to predict susceptible locations and select locations for inspection. Vermont Yankee's use of these five criteria to identify susceptible locations and select examination locations provides assurance that susceptible locations will be identified and inspected.

Q36. Is CHECWORKS sufficient to predict FAC at Vermont Yankee during the period of extended operation?

A36. (Hsu) The UT inspection results are entered into CHECWORKS, which determines the actual wear rate and recalibrates itself. The actual wear is used to trend/predict by CHECWORKS. As long as all the operating parameters are correctly

entered, CHECWORKS is sufficient to trend/predict throughout plant life. Also, as previously stated, Vermont Yankee is not relying solely on CHECWORKS to identify susceptible locations for inspection but has four additional criteria: components identified in pervious inspections, industry experience, susceptible piping not modeled by CHECWORKS, and engineering judgment.

Q37. Will Vermont Yankee have enough plant specific data prior to the period of extended operation to recalibrate CHECWORKS to EPU conditions during the period of extended operation?

A37. (Hsu) Yes, as mentioned above, in Section 2.1.6 of Safety Evaluation Report of VY EPU (ML060050028) (Staff Exh. 14) reported: "The licensee has determined that an increase in the velocities in the main steam line and feedwater lines will cause proportional increases in FAC wear rates" and the Staff agreed. On the basis of the above statement, Vermont Yankee needs only one inspection to confirm FAC ware rate for EPU period for those components that have inspection data from last outage. (If this was not the case, two continuous inspections are required to input data into CHECWORKS to determine the actual wear and recalibrate itself.) Vermont Yankee has conducted 63 inspections for pipe-wall thinning since the EPU. The licensee reported to the ACRS Subcommittee that the inspection results were satisfactory and consistent with analytical predictions that VY use in its modeling for FAC. Exh. NEC-UW_13 at 38. Additional inspection data can be used to confirm FAC wear rate and refine the model.

Q38.. Will the data collected from the remaining scheduled outages prior to license renewal using Vermont Yankee's existing FAC program be sufficient to calibrate CHECWORKS to post-EPU conditions?

A38. (Hsu) Yes, Entergy stated that the number of piping inspections will be increased by 50% for the next three refueling outages. The first inspection has been completed and the results can be used to demonstrate its trend/prediction. Vermont Yankee reported to an ACRS Subcommittee that 63 inspections have been completed and all were satisfactory and consistent with analytical predictions that Vermont Yankee use in its modeling for FAC. Exh. NEC-UW_11 at 43. Vermont Yankee will continually use the model to pick the areas to inspect and feed data into CHECWORKS. The data from these inspections is entered into CHECWORKS, which determines the actual wear and recalibrate itself. It's an ongoing cycle, a living program.

Q39. Why did the Staff conclude that Vermont Yankee's FAC program, which includes CHECWORKS, is adequate to monitor and manage the plant piping due to FAC?

A39. The Staff concluded that Vermont Yankee's FAC program is adequate to address the plant FAC issues and its basis follows: (1) Vermont Yankee's program is consistent with Staff-endorsed GALL Report recommendations. (2) Vermont Yankee's Commitment No. 51, as stated in SER for the LRA, addresses staff's concern for license renewal applicants with approved EPUs. (3) Vermont Yankee's detailed FAC discussion, as shown in BVY 04-008 (Staff Exh. 17), adequately addressed the impact of EPU on all susceptible systems.

On these bases the Staff concluded that Vermont Yankee/Entergy demonstrated that the effects of aging FAC on plant piping will be adequately managed so that the intended functions will be managed consistent with the CLB for the period of extended operation, as required by 10 C.F.R. § 54.21(a)(3).

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