RAS M-241

EVALUATION OF VERMONT YANKEE NUCLEAR POWER STATION LICENSE EXTENSION: PROPOSED AGING MANAGEMENT PROGRAM FOR FLOW ACCELERATED CORROSION

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I. Introduction

I submit the following comments in support of the New England Coalition, Inc.'s ("NEC") Contention 4. My comments concern the Applicant's aging management program, specifically addressing the fidelity of the Flow-Accelerated Corrosion ("FAC") Program (NEC Contention 4).

NEC asserts that the application for License Renewal submitted by Entergy for Vermont Yankee does not include an adequate plan to monitor and manage aging of plant equipment due to flow-accelerated corrosion ("FAC") during extended plant operation. The Applicant has represented that its FAC management program during the period of extended operation will be the same as its program under the current operating license, and consistent with industry guidance, including EPRI NSAC 202L R.3. The use of the CHECWORKS model is a central element in the Program implementation.

In the Applicant's motion for summary disposition, the Applicant proffered a response that credits the its current program for FAC management at the facility, and simply extends the current program for the renewal period, making the following statement: "furthermore, the FAC program that will be implemented by Entergy is the same program being carried out today, which has not been otherwise challenged by NEC, will meet all regulatory guidance." Ref. Entergy Motion for Summary Disposition on New England Coalition's Contention 4 (Flow Accelerated Corrosion), June 5, 2007, at 3. Italics added.

The Applicant has asserted that it is in full compliance with its current licensing basis regarding its FAC program. The Applicant asserts that the plans for monitoring flow

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accelerated corrosion, including the FAC Program goal of preclusion includes appropriate procedures or administrative controls to assure that the structural steel integrity of all steel lines containing high-energy fluids is maintained. *Id* at 6. The applicant is argues that since the VY FAC program is based on EPRI guidelines and has been in effect since 1990, one could therefore conclude the applicant has established methodology so as to preclude of negative design margin or forestall an actual pipe rupture, and Entergy infers that it is technically adequate and is compliant with its licensing basis requirements.

I draw a different conclusion. Based on the *implemented* program presently in place, and the historical inadequacies necessary for effective implementation (including evolution) of the FAC program, the oversights are substantial in program scope, application of modeling software, and finally necessary revisions to the program not implemented as was promised to support the power up-rate. I am not alone in this conclusion. Program weaknesses and failures have been identified by others and form the basis of condition reports, the categorization as *unsatisfactory* in a Quality Assurance Audit dated November 11, 2004[1], and noted as "yellow" in a cornerstone roll-up report circa 2006[2]. In addition, the NRC Project Manager made a recent inquiry into indications of an out-of-date program.[3] On Monday, April 21, 2008, I spoke by phone with NRC resident inspector Beth Sienel, and she confirmed that, even now, Entergy has not completed verification of the upgrade of the CHECWORKS model to EPU design conditions. This concern regarding deficiencies in implementation of the program brings

[1] Exhibit NEC-UW_9, Audit No.: QA-8-2004-VY-1, "Engineering Programs", page 2, (NEC038514).

[2] Exhibit NEC-UW_7, Cornerstone Rollup, Program: Flow Accelerated Corrosion, Quarter: 3rd, dated 10/03/2006, page NEC038424, Open Action Items, (includes All CR-CAs, ER post action items and LO-CAs, is shown as "yellow", however, 6 LO-CAs are shown as open. By definition, "Red" includes 2 or more CR-CAs and /or E/R post action items (excluding LOs action items) greater than one year.

[3] Exhibit NEC-UW_14.

into question the results of FAC inspection during RFO 25 and RFO 26, in which power up-rate design data apparently is as yet not incorporated.

These program implementation delays are substantive, and based upon the information provided to NEC appear to remain unresolved. These deficient conditions raise questions as to the fidelity of the entire license renewal application, Entergy's commitments for license renewal, management oversight, and the efficacy of the regulatory-required Corrective Action Program.

If it is true that power up-rate parameters such as flow velocity were not incorporated into the FAC program model, these deficiencies appear to be substantive and without question warrant condition reports under the Entergy Corrective Action Program, in particular given that they appear to violate regulatory commitments regarding the Flow Accelerated Corrosion Program.

10 CFR Part 50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," provides that a condition that is deficient is *required* to be identified, investigated, and remediated expeditiously.[4] Promises to correct the deficient program at some point in the future are not sufficient, unless all reasonable alternative methods for remediation are exhausted and the condition is shown to be safe in the interim. Lack of oversight and a *single missed inspection point* that remained unnoticed

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[4] 10CFR Part 50, Appendix B, XVI, "Corrective Action," states: "Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and non-conformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management."

for years[5] led the Japanese Mihama Plant FAC pipe rupture in 2004, causing five fatalities.[6] As discussed in detail below, Vermont Yankee missed dozens of points.

Identification of discrepancies and timely corrective action are the cornerstones of a well-managed plant. In my experience assisting problematic plants, change usually begins with a cultural shift toward proactive corrective action and away from a reactive mentality of delaying needed corrective actions to programs such as FAC that result in unresolved deficient conditions and unnecessarily narrowed safety margins for longer periods of time than are necessary.

A common metric used by the regulator (for example in ROP reviews) and management is the volume of the backlog of open corrective actions and the number of open corrective actions that date further back than one year, two years or even three or more years, to establish the fidelity of the licensee's compliance with the terms of its operating license and associated commitments. The metric is useful in evaluating Flow Accelerated Corrosion management at Vermont Yankee.

II. Summary Assessment

~~Based on a detailed review of the record provided to NEC regarding the Flow-Accelerated Corrosion Program, my conclusion is that the FAC program appears to have been in non-compliance with its licensing basis from about 1999 through February 2008.~~ The failure to comply is evidenced by the licensee's own assessments, audits, and condition reports, roll-up of numerous cornerstone reports, and focused self-assessments. Corrective actions from approximately five Condition Reports ("CR") remained open for

[5] Exhibit UW_20, Page 6 of 14 of VY FAC Inspection Program PP7028, 2005 refueling outage at NEC037109.

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[6] *Kepco Ordered to Shut Down Mihama Reactor.* The Japan Times, September 28, 2004, *available at http://search.japantimes.co.jp/member/member.html?nn20040928a6.htm.*

as much as four years. The last condition report regarding FAC, CR 2006-2699, was written on August 30, 2006. Although noted in the cornerstone report dated October of 2006[7], the condition report apparently was never provided to NEC. The condition report aggregated approximately six corrective actions to the program that had been ignored and the current status was then open and which is presently unknown to NEC.

In addition, the most recent FAC inspection was performed under superseded procedures and the results therefore are of potentially no programmatic value[8]. Procedure ENN-DC-315, was revised and in effect on March 1, 2006, yet superseded on December 1, 2006 by yet a new program level procedure. Close examination shows that the procedures prepared, approved and implemented by Entergy for implementing the FAC Program were substantially revised, yet were not used in the most recent flow-accelerated corrosion inspections after VY increased operating power by 20 percent in the March, 2006 EPU, nor were they available for RFO 25, the first outage after power up-rate. Required changes, including both a software upgrade and design parameters regarding the substantial plant modification to uprate the plant to 120% power, were not incorporated for either outage, and were in fact still being implemented in February 2008, when Staff inquired on this subject.

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[7] Exhibit NEC-UW_07 Cornerstone Rollup, Program: Flow Accelerated Corrosion, Program Infrastructure Cornerstone, Quarter: 3rd, dated 10/03/2006, page NEC038419 ("Corrective Action Plan to complete open LO-CA tasks developed 10/02/2006, (CR-2006-02699)"). *See also* pp. NEC038422, NEC038424, NEC038426-28—see also footnote 3.

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[8] Exhibit NEC-JH_42, VY Piping FAC Inspection Program PP 7028- 2007 Refueling Outage, Inspection Location Worksheets/ Methods and Reasons for Component Selection," April 3, 2006, at 1, NEC017888.

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[redacted]. The Feedwater System FAC review was run using 1999 Ultrasonic Test ("UT") data, yet the results were not used in the RFO 24 outage.

To be an even marginally predictive modeling tool, the CHECWORKS model should have been kept current for successive outages, [redacted][10]) that were required to be managed for FAC as far back as 1999. The predictive capability of CHECWORKS was virtually non-existent for the period from 1999 forward. Although Entergy did incorporate the program, which depends heavily on trending of data of multiple outages, they incorporated in one plunge plant design conditions during the 3rd quarter 2006. The scoping document supporting selection of grid points collected essentially all the sins of the past, including, for example, stale predictive inspection data from the out-of–date version of CHECWORKS, and placed heavy reliance on engineering judgment. As provided under the 2005 scoping document[11],

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[11] Exhibit NEC-UW_20, PP7028 Piping FAC Inspection Program, FAC Inspection Records for 2005 Refueling Outage, undated, NEC037099. Includes on page NEC037104, Inspection Locations and Reasons for component selection, dated 3/1/05. Note on page 2 of 14 of this report, exclusions of inspection scope were based upon cycle predictions from 1999, and did not appear to include Uprate design changes, nor account for the EPRI model not being current. Many recommendations from 1999 were not to reinspect until 2007—or 9 years. This approach appears to be entirely inconsistent with NSAC 202L. Newer examinations

the rationale for selection of grid points relied on (1) length of time since the lapsed inspections had ceased to examine a particular inspection point, (2) CHECWORKS User Groups, (CHUG) suspects found at other plants, (3) exclusion of components that were intended to be replaced based upon another regime or degraded condition.

Had data from previous FAC inspections routinely been entered into CHECWORKS, the selection of grid points and ranking would have provided a better historical perspective on where to inspect in successive outages, including the most recent outage. With the exception of VY's strength in reactively replacing piping or components with FAC-resistant material during repairs or maintenance, the program itself was not effective as a predictive modeling tool. Simply stated, once something ruptured or was found to be outside its design margin, it was replaced in a reactive management approach. Proactive management of the program to *predict failures* has been inadequate in the FAC Program, as referenced above.

Even the most recent inspection completed for RFO 26 appears to have been structured around procedures that were superseded, scoping requirements to establish a new baseline of pipe geometry and as-found wall thickness were based on stale data, and the upper-tiered governing procedure that was used had not been revised since 2001 and was therefore void.[12]

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showed an trend of increased frequency of reinspection . See NEC037106. Page 4 of 14 provides for negative margin, or no inspections for Feedwater System. Conclusions called for "assessing the need" for inspections in 2007 outage. See page NEC037107. The condensation system showed one component with negative time to Tmin. The Extraction Steam System indicated three components with negative time to code min wall. Page NEC037108.

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[12] Exhibit NEC-UW-11, Official Transcript of Proceedings ACRST-3397, Advisory Committee on Reactor Safeguards Subcommittee on Plant License Renewal, June 5, 2007, at page 43. Entergy's Mr. Dreyfuss stated: "...we did increase the number of FAC inspections by 50 percent from what we typically do in outages. We did 63 inspections overall." It is also noted that the average number of points examined by the domestic industry is 82—under a well managed program, without significant changes to the model—such as a power uprate.

The current program-level procedure had been in existence since March 2006. Scoping was performed in May of 2006 under the void procedure, and updating of CHECWORKS was not done until 3rd quarter 2006.[13] Grid points, scope selection, and small bore piping susceptibility do not appear to have been ranked under NSAC 202L guidance or in an orderly trending of data by CHECWORKS based upon repeated passes with new grid points and new rankings selected. Data input and passes by CHECWORKS were not accomplished on an outage-by-outage basis.[14]

With only 63 points examined in RFO 26[15], the baseline for the power up-rate conditions appears not to have been established. I found it troubling that RFO 26 results were provided to the Advisory Committee on Reactor Safeguards ("ACRS") on June 5, 2007, but apparently were not disclosed to NEC.

VY is the first plant modified to achieve Constant Pressure Power Up-rate to 120% power and only one other plant out of the fleet of 104 was licensed to 120% increase in power in one step. Given the uniqueness of the design of VY's power up-rate, CHECWORKS has little industry benchmarking data, and is of marginal use.

The history of the one other up-rated power plant, Clinton Power Station, suggests the possibility of future problems at Vermont Yankee. The NRC inspected Clinton Power Station, including a review of the FAC program, after its up-rate in January 2003 and found the program to comply with its licensing basis, including NSAC 202L and the use

[13] Exhibit NEC-UW_07 at NEC038424.

[14] Exhibit NEC-UW-20, VY Piping FAC Inspection Program PP 7028- 2005 FAC Inspection Program Records for 2005 Refueling Outage at NEC037112 –NEC037120.

[15] Exhibit NEC-UW-11, Official Transcript of Proceedings ACRST-3397, Advisory Committee on Reactor Safeguards Subcommittee on Plant License Renewal, June 5, 2007, at page 43. Entergy's Mr. Dreyfuss stated: "...we did increase the number of FAC inspections by 50 percent from what we typically do in outages. We did 63 inspections overall." It is also noted that the average number of points examined by the domestic industry is 82—under a well managed program, without significant changes to the model—such as a power uprate.

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of CHECWORKS. Program inputs were fully incorporated from previous inspection data and heat balance up-rate data. Wear rates were predicted to increase 8% because of up-rated power conditions. Although the increase was a concern to the regulator, the program was found to be adequate. Yet only nine months later, Clinton experienced a FAC rupture[16]. *It is relevant that this failure occurred approximately 16 years after Clinton* received its operating license in 1987—while apparently complying with its CLB and the EPRI guidance.[17]

Plant Surry, where a rupture due to FAC killed four people, failed after 15 years of operation, and required 190 component replacements due to FAC. The accident led to unpredicted causal events outside the engineering design basis—including discharge of CO_2, seepage of the heavier than air gas into the control room, requiring reactor operators to don Scott air packs and with some operators exhibiting symptoms such as dizziness because of control room habitability[18]. Pleasant Prairie, a fossil plant with similar conditions, endured a catastrophic FAC failure at 13 years, causing two fatalities[19], and a Japanese plant failed without warning, killing five people, simply because of a failure to inspect one component section due to an administrative oversight, repeatedly missed by program owners.[20] The oversight was never noticed during quality control or quality assurance reviews, or spotted by the system engineers responsible for FAC at the plant.

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[16] Exhibit NEC_JH-42 at 7 (NEC017894).

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[17] Exhibit NEC_UW-04; Exhibit NEC_UW-05 at §XI.M17.

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[18] Exhibit NEC-UW_22 U.S. NRC NUREG 0933; Issue 139: thinning of Carbon Steel Piping in LWRs (Rev. 1) at 1-4.

[19] Exhibit NEC_UW-21, Milwaukee Sentinel, March 9, 1995.

[20] Exhibit NEC_UW-20 at NEC037109.

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These plants were not specifically using aging management tools, where as others, such as Clinton, did—but each FAC failure occurred well before the plants reached their engineered end-of-life of 40 years. The event at Mihama occurred due to nothing more than an administrative failure to routinely inspect a known FAC-susceptible component.

I fully concur with NEC's consultant Dr. Joram Hopenfeld that comprehensive benchmarking will be required through the number of years when unmanaged FAC failures typically begin to emerge, such as the operational age of the Surry plant at the time of FAC failure, or the Clinton Plant failure.

III. Licensing basis for management of flow-accelerated corrosion at VY and review of the program implementation

I reviewed the FAC program in four parts: Part A, examining the current licensing basis; Part B, the *implementation* of the licensing basis; Part C, the Licensee's *own record* of problems with implementation; Part D, *my independent observations* based on the record provided to NEC, and the requirements for implementing an effective program under NRC-endorsed guidance, with which the Licensee has stated that it has complied.

A. The current licensing Basis and the proposed licensing basis for the flow accelerated corrosion program:

My review to establish the current licensing basis and the current status of application for license renewal includes the following documents:

1. NUREG 1801 Rev 1, §XI-M17, Flow Accelerated Corrosion

[redacted]

[redacted]

3. CHECWORKS EPRI procedures provided by the Applicant, including fleet procedure EN-DC-315, Rev. 0, "Flow-Accelerated Corrosion Program" effective December 1, 2006.

4. Commitments made by the licensee including the following:[22]

   i. USNR generic letter 89-08, Erosion corrosion –induced pipe wall thinning;
   ii. Vermont Yankee Letter to USNRC;
   iii. Vermont Yankee letter to the USNRC, Vermont Yankee Response to NRC Bulletin No. 87-01: Thinning of Pipe Walls in Nuclear Power Plants, dated September 11, 1987;
   iv. Vermont Yankee letter to the USNRC, Supplement to Vermont Yankee Response to NRC Bulletin No. 87-01: Thinning of Pipe Walls in Nuclear Power Plants, dated December 24, 1987;
   v. USNRC Generic Letter 90-05, Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2 and 3 Piping, dated June 15, 1990;
   vi. Vermont Yankee letter to the USNRC, request from code relief for use of ASME Code Case N-597, as an alternative to analytical evaluation of wall thinning;
   vii. USNRC letter to Vermont Yankee, Vermont Yankee Nuclear Power Station—Relief request for use of ASME code case N-597 as an Alternative Analytical Evaluation of wall thinning (TAC No. MB1530) dated July 27, 2001. NVY 01-74;
   viii. VY memo: J.F Calchera to OEC (R. McCullough), subject: response to commitment item: ER-990876_01, Reevaluate Feedwater Heater Inspection Program to address Ownership, dated April 25, 2000.

Industry guidance and other records that were used for interpreting VY position regarding license renewal include:

   ix. Flow accelerated corrosion in power plants TR-106611-R1, published by EPRI in 1999;
   x. Official Transcript Advisory Committee on Reactor Safeguards subcommittee on Power Uprates November 30, 2005;
   xi. RAI SPLB-A-1 (LR001576);
   xii. Section 12-2 Wear rate analysis (Excerpt from an EPRI report);

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[22] Items i., ii, iii, iv, and viii listed as commitments were not provided to NEC but were only referenced in Entergy's program level documents, and therefore were not directly reviewed. They do not appear on Entergy's Appendix A, licensee renewal list of commitments, but are listed in program level documents that were valid until March 15, 2006. No evidence of withdrawal, modification, or otherwise changes to these commitments was provided to NEC.

xiii. VYNPS License renewal Project Aging Management Program Evaluation Results. (NEC00113191)

B. Implementation of the Flow Accelerated Program in accordance with the CLB.

I reviewed the following documents to ensure the implementation of the FAC program in accordance with the CLB:

xiv. ENN-DC-315, Rev. 1, "Flow Accelerated Program;"
xv. VY-PP7028, Piping Flow Accelerated Corrosion Inspection Program;
xvi. VY –PP7028, FAC Inspection program PP 7028- 2007 Refueling outage;
xvii. VY -PP7028, piping inspection program, FAC inspection records for 2005 refueling outage;
xviii. ENN-CS-S-008, rev 0, effective 9/28/2005, pipe wall thinning structural evaluation;

xix. DP-0072.

C. Review of Inspection Histories, EPRI Reviews, Quality Assurance Reports, Cornerstone Roll-ups, Focused Self assessments, Condition Reports, and Independent Assessments, and NRC Inspection Reports.

In addition, I reviewed inspection histories, condition reports, quality assurance reports, and one cornerstone report rollup on trending in the FAC Program (2003)- through October, 2006), NRC Inspections, and various revisions to VYLRP subsections and revisions. The list included the following:

xx. Focused Self Assessment Report, Vermont Yankee Piping Flow Accelerated Corrosion inspection report, Condition Report LO-VTYLO-2003-0327;
xxi. Audit No. QA-8-2004-VY1, Engineering Programs, dated 11/22/2004;
xxii. EPRI review of Vermont Yankee Nuclear Power Flow-accelerated corrosion, dated February 28, 2000;
xxiii. CR –VTY-2005-02239;
xxiv. Cornerstone Rollup update last dated 10/23/2006;

xxv. VYNPS License Renewal Project Aging management Program Evaluation Results.23

D. Current status of the FAC Program with respect to the licensing basis.

1. The current licensing basis goal is to preclude negative design margin or pipe rupture due to Flow-Accelerated Corrosion and is centered around use of EPRI document NSAC 202L. The guidance is specifically endorsed by the NRC under NUREG 1801, which calls for a three prong approach to minimize uncertainties:

(1) Use of a model such as CHECWORKS [with precision in data collection, examination, and frequency];

(2) Use of sound engineering judgment in selecting inspection points that are independent of CHECWORKS; and

(3) Use of industry events that have potential relevance to VY in material condition, design parameters, and operating history.

There are numerous FAC-related failures throughout the industry. Examination of the OECD Pipe Failure Data Exchange Project (OPDE) database provides that information.[24]

2. To accomplish the licensing basis goal, the FAC Program needs explicitly to include each of the following ten elements under the specific Generic Aging Lessons Learned (GALL) Report:

1. Scope
2. Preventative actions
3. Parameters monitored or inspected

[23] These documents were typically provided to NEC in fragments, with no title page, no document date, no record of whether the documents were current and had superseded others, and no signature or references to the author.

[24] Exhibit NEC-UW_15, NucE 597D-Project 1, Data Collection of Pipe Failures occurring in Stainless Steel and Carbon Steel Piping. provides industry wide data on FAC failure. Page 20 includes a failure rate for BWR plants. The probabilistic risk assessment for BWR plant FAC failures is reported as 10E-5 (higher than reactor accident threshold PRA for Design Basis Accidents).

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4. Detection of aging effects

5. Trending

6. Acceptance criteria

7. Corrective actions

8. Confirmation processes

9. Administrative processes

10. Operating experience[25]

3. Implementation of these ten elements is accomplished under formal program-level procedures. Successful implementation requires actions in sequence that are constructive to yielding the highest predictability of wall thinning and the most certainty in ranking test points for inspection on a routine that collects wear data in a timely fashion, then adjusts the selection scope based upon multiple trending of data, along with incorporation of changes to the plant.[26]

4. [redacted] [redacted].[27] The record indicates that the Vermont Yankee Nuclear Power Station ("VYNPS") FAC program only partially implemented its licensing basis requirements to achieve a successful FAC program and that Entergy was aware of the problematic state of the program for many years.[28]

[25] Exhibit NEC-UW_06 at 152-157; Exhibit NEC-UW_08 at 2.

[26] Exhibit NEC-UW_15 at 20. This Exhibit provides industry-wide data on FAC failures. The high rate of failure in BWR plants underscores the need for precision in implementing an FAC program.

[27] Exhibit NEC-JH_38 at 3-3, 4-1.

[28] Exhibits NEC-JH-42 at NEC017893-912; Exhibit NEC-UW-09 at NEC038514, NEC038515, NEC038529, NEC038531-038533; Exhibit NEC-UW_07 at NEC038422.

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5. The self-identified deficiencies in Entergy's current VYNPS FAC Program are identified in multiple documents. [redacted][29] Entergy apparently ignored the warning. More troubling is that Entergy continued to be in non-compliance with its licensing basis through the years 1999-2006. This deficiency was again noted in late 2004 under an internal quality assurance audit, and two Condition Reports were written.[30]

6. Relevant data apparently was not entered into the CHECWORKS model until the third quarter of 2006.[31] The October 23, 2006 rollup thus confirms that the model was not kept current during a seven-year period and suggests that susceptible locations may not have been inspected during this time period. This lengthy lapse significantly weakened the trending capability of the software, both during the lapse period and presently. It is also evident that EPU data was still being modeled and validated in 2008.[32] [redacted]

[29] Exhibit NEC-UW-08 at 1, 4-6.

[30] Exhibit NEC-UW-09 at 2, NEC038531-NEC038555, "CR-VTY-2004-03062" and "CR-VTY-2004-03061."

[31] Exhibit NEC-UW-07 at NEC038424 ("CHECWORKS models and wear data analysis updated with all previous inspections in 3rd quarter 2006.").

[32] Exhibit NEC-UW_14, Email from Beth Sienel to Jonathan Rowley, Feburary 20, 2008, [redacted]

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In spite of Entergy's commitment, the required additional susceptibility scoping analysis is not apparent to NEC in information provided.

7. From 1999-2006, the plant was essentially operating in a state in which component wear was improperly trended and pipe conditions were actually unknown. Reliance on CHECWORKS for this time period for predicting grid points, ranking susceptible components, and inspecting new points was therefore virtually without technical or empirical value. Without proper trending, the predictability goal of CHECWORKS is lost; it essentially became a data collection repository.

8. During the years 2000-2006, the VYNPS FAC program apparently used an outdated version of the CHECWORKS software. [redacted] Entergy's failure to

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[34] [redacted].

[35] Exhibit NEC-UW-08 at 5-6; NEC-UW-20 at NEC037103.

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update the CHECWORKS model in a timely fashion makes data comparison between operating cycles more difficult.

9. In 2004, at least four VYNPS components, including the condensate system and the extraction steam systems, were determined to have "negative time to Tmin," meaning that wall thinning was being predicted as beyond operability limits and should be considered unsafe with potential rupture at anytime.[36] "Negative cycles of operations," meaning wall thinning *beyond* acceptable code limits, were also predicted. The hours negative to the next inspection were substantial—predicting potential code violation or failure could have occurred 3000+ hours previously to October 23, 2006. It is surprising that the Licensee apparently did not write condition reports for this condition. I do not believe that NEC received any notice of Condition Reports relevant to this significant indication by CHECWORKS predicting substantial wall thinning beyond code limits to occur with negative margin of this magnitude. This issue is particularly troubling given that the equipment failure event is unpredictable, and catastrophic when wall thinning is beyond acceptable limits. Despite CHECWORKS' prediction of wall thinning, the plant continued to operate. I have not seen any inspection or audit discussion of this situation. It does, however, appear on the RFO 24 Inspection Plan,[37] oddly with the same number of hours of negative time to Tmin, even with the plan including wear data observed of 30% increase at Quad Cities and Dresden after the up-rate.[38]

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[36] Exhibit NEC-JH-42 at NEC017893. *See also* NEC-UW-20 at NEC037108.

[37] Exhibit NEC-JH_43 at NEC020189.

[38] Id. at NEC020197.

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10. The VYNPS FAC program was deemed unsatisfactory under quality assurance review dated November 22, 2004, and two condition reports were written.[39] On page 5, the report notes the need for program management to ensure update of susceptible piping to be identified and modifications to be incorporated.[40] In addition, the report notes that cross-discipline review required by procedure had not been performed.[41]

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11. The 2006 cornerstone report shows a number of indicators as yellow, with lists of open CR corrective actions, and a new CR written in August 30, 2006.[42] The report lists six corrective actions and four CRs that were written as early as 2003 that remain open.[43] These include references to a number of progress indicators, but authors of the report continue to express concern over the program and the slow progress to update the CHECWORKS model. I reviewed several of the listed condition reports, some more than four years old, and found no indication that corrective actions recommended in these reports were completed.

12. In addition, in 2005 a sixth CR was written, CR-VTY-2005-02239, stating "CHECWORKS predictive model for Piping FAC inspection program was not updated per appendix D of PP7028."[44] The first page of the CR includes a statement that this condition had no impact on the RFO 25 inspection scope – i.e., indicating that updating of CHECWORKS was not necessary for establishing scope of RFO 25. This assertion is

[39] Exhibit NEC-UW-09 at 2 (NEC038514).

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[40] Exhibit NEC-UW-09 at 5 (NEC038517).

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[41] Id.

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[42] Exhibit NEC-UW-07 at NEC038419, NEC038422.

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[43] Exhibit NEC-UW-07 at NEC038424.

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[44] Exhibit NEC-UW-10 at 1.

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another indicator that the VY FAC program was *prima facie* in noncompliance with its CLB.

13. A review of a focused self-assessment was performed. This assessment was called for under one corrective action from a condition report LO-VTYLO-2003-00327. The report identifies numerous issues that required or require action to bring the FAC program into compliance with the CLB. For example, the program susceptibility review report for 2004 was not formal, and did not properly separate scope for ranking.[45] The report was not given an adequate review, nor placed in the document control system.

14. PP7028 notes plant modifications and inspection results as not updated since May 15, 2000.[46]

15. Ranking of small-bore piping was not done. With no ranking, the basis for selection of high susceptibility points for small-bore piping is not evident.[47] Procedural conflicts were identified with missing programmatic requirements.[48]

16. A flow-accelerated corrosion related pipe break associated with a 1" elbow, SSH (WO 06-6880), appears to have occurred in 3rd quarter 2006.[49]

17. Entergy apparently reduced the number of FAC inspection data points between the 2005 refueling outage and the 2006 refueling outage, in violation of its commitment to *increase* inspection data points by 50%. The 2005 refueling outage inspection called for

[45] Exhibit NEC-JH_44 at 17.
[46] Id. at 18.
[47] Id. at 19.
[48] Id. at 27-29.
[49] Exhibit NEC-UW-07 at NEC038428.

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137 large-bore inspection points. The 2006 refueling outage inspection, presented to the ACRS on June 5, 2007, covered only 63 points.[50]

18. The 2006 refueling outage FAC inspection scope, planning, documentation, and procedural analysis all appear to have been performed under a superseded program document. ENN-DC-315 Rev.1 was effective March 15, 2006, superseding the PP7028 Piping FAC Inspection Program.[51] Yet VY inspection plan for FAC Program PP7028 was approved on May 11, 2006, almost two months after the PP7028 program document was superseded.[52] This error potentially invalidates the baseline requirement of CHECWORKS, in accordance with NRC-endorsed guidance, to establish the as-found condition of components and piping.[53] The fundamental step of updating inputs is required in the NSAC 202L approach for FAC, and is a required step in the CHECWORKS instructions. Essentially, working to a void procedure makes the results invalid [redacted] Given the significant changes to the plant, a baseline pass with accurate inputs was necessary, and subsequent passes were necessary to establish the grid locations and high susceptibility inspection points.

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[50] Exhibit NEC-UW-11 at 43.

[51] Exhibit NEC-UW-12 (ENN-DC-315) at 1; Exhibit NEC-UW-19 (PP7028).

[52] Exhibit NEC-JH-42 at NEC017888.

[53] Exhibit NEC-UW-06 at § XI.M17.

[54] Exhibit NEC-JH-38 at 4-5.

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19. No indication is provided that plant isometrics were updated as required as of 10/22/04.[55]

IV. Time needed to benchmark CHECWORKS for Post-EPU use at VYNPS

I agree with the testimony of Dr. Joram Hopenfeld that CHECWORKS is an empirical model that must be updated with plant-specific data. NUREG 1801 does not specify the number of years' data necessary to benchmark CHECWORKS, but does advise that a baseline must be established as noted above [redacted] This requirement is reasonable given that each plant has unique characteristics and operating history. Separate industry guidance supports five to ten years of data trending.[57] Trending to the high end of the range is appropriate where variables affecting wear rate, such as flow velocity, have significantly changed, as at VYNPS following the 120% power up-rate.

Given the deficiencies in the current VYNPS FAC program discussed in this statement, trending under the program is of marginal value. In addition, substantial "negative margin" conditions were identified in scoping the 2005 FAC inspection—many of which were predicted because of the repeated missed inspections in previous outages (that, significantly, occurred prior to up-rate).

[55] Exhibit NEC-JH_44 at 19.

[56] [redacted]

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[57] Exhibit NEC-UW-13 at 38 ("In order to establish a baseline for the plant's equipment performance and reliability, the operating history over the past 5 to 10 years is reviewed and trended.").

I do not agree that a prolonged period of data collection is not necessary to use CHECWORKS effectively at VYNPS after the 120% power up-rate because the predictive algorithms built into CHECWORKS are based on FAC data from many plants. VYNPS is unique in its approach of Constant Pressure Power Up-rate to 120%. Clinton is the only other plant to accomplish a one-step up-rate to 120% power and is a very different plant from VY. To my knowledge, out of 104 operating plants only six have increased operating power by more than 15%.[58] Of this group, at least three – Clinton, Dresden, and Quad Cities – appear to have FAC-related issues.[59] The argument that CHECWORKS incorporates relevant industry data is difficult to accept when so few plants are operating under analogous conditions, and 50% of those have experienced FAC related problems.

The need to extend the period of data collection is further evidenced by the fact that the CHECWORKS model was not updated with plant-specific changes until after RFO 26. Furthermore, by inference from an inquiry by the Staff project manager to the resident inspectors office only two months ago, it appears the NRC was informed that the EPU up-rate conditions *were still being verified and the process was at this late date incomplete after two outages had passed* since EPU design was completed, licensed, and implemented. The apparent failure to update the program underscores the lack of benchmarking done to date regarding the CHECWORKS software, and demonstrates troubling failures by Entergy to adhere to their own procedural requirements and failure to honor commitments made to the regulator, for example, made to the ACRS in November

[58] Exhibit NEC-UW_18, Union of Concerned Scientists, "Power Uprate History," July 12, 2007.

[59] Exhibit NEC-UW_20 at NEC037109, NEC037116; JH_42 at NEC017894, NEC017897, NEC017898; JH_43 at NEC020196.

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2005, regarding use of the tool and the applicant's intention to conduct benchmarking testing during RFO 25 and RFO 26.

Based on the foregoing, it is my opinion that seven or more cycles will be necessary to establish a credible benchmarking of CHECWORKS to VYNPS under up-rated operating conditions [redacted] It is also my opinion that benchmarking can only be accomplished after the current program deficiencies are corrected and a proper baseline is established.

[60] Exhibit NEC-UW-08, [Proprietary] [redacted]