

RAS 4-227

In the Matter of Entergy Nuclear Vermont Yankee LLC  
Docket No. 50-271 Official Exhibit No. NEC-JH-61  
OFFERED by: Applicant/Licensee Intervenor NEC  
NRC Staff Other  
IDENTIFIED on 7/23/08 Witness/Panel Hogan/Ed  
Action Taken: ADMITTED REJECTED WITHDRAWN  
Reporter/Clerk MAC

NEC-JH\_61

April 18, 2007

**UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION**

Before the Atomic Safety and Licensing Board

DOCKETED  
USNRC

August 12, 2008 (11:00am)

OFFICE OF SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

In the Matter of )  
)  
Entergy Nuclear Vermont Yankee, LLC )  
and Entergy Nuclear Operations, Inc. )  
)  
(Vermont Yankee Nuclear Power Station) )

Docket No. 50-271-LR  
ASLBP No. 06-849-03-LR

**DECLARATION OF JOHN R. HOFFMAN IN SUPPORT OF ENTERGY'S MOTION  
FOR SUMMARY DISPOSITION OF NEC CONTENTION 3**

John R. Hoffman states as follows under penalties of perjury:

**I. Introduction**

1. Prior to September 2006 I was employed by Entergy Nuclear Operations, Inc. ("Entergy") and had, among other responsibilities, that of Project Manager for the License Renewal Project at the Vermont Yankee Nuclear Power Station ("VY"). I retired from Entergy's employment in September 2006. I am currently a consultant and provide this declaration in support of Entergy's Motion for Summary Disposition of New England Coalition's ("NEC") Contention 3 ("NEC Contention 3") in the above captioned proceeding.

2. My professional and educational experience is summarized in the *curriculum vitae* attached as Exhibit 1 to this declaration. Briefly summarized, I have over 37 years of nuclear power engineering experience, and have been associated with VY since 1971.

3. During my employment at VY I had no direct involvement with the power uprate implemented between 2003 and 2006. However, I have reviewed relevant materials and conducted interviews with plant personnel to familiarize myself with the manner in which steam dryer issues were addressed during the uprate process. I have personal knowledge of the manner in which VY intends to address the steam dryer during the period of extended operation.

4. NEC Contention 3 asserts 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." This contention lacks technical or factual basis.

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5. I will demonstrate that the plan proposed by VY for monitoring and managing aging of the steam dryer during the period of extended operation is adequate and is consistent with manufacturer recommendations and the practice in the industry.

## **II. Background**

6. In a boiling water reactor ("BWR"), the steam dryer is a stainless steel component whose function is to remove moisture from the steam before it leaves the reactor. The dryer is mounted in the reactor vessel above the steam separator assembly and is latched to the inside of the vessel wall below the steam outlet nozzles. Wet steam flows upward and outward through the dryer. Moisture is removed by impinging on the dryer vanes and flows down through drains to the reactor water in the downcomer annulus below the steam separators.

7. The steam dryer does not perform a safety function and is not required to prevent or mitigate the consequences of accidents. The VY steam dryer is a non-safety-related, non-Seismic Category I component. Although the steam dryer is not a safety-related component, the assembly is designed to withstand design basis events without the generation of loose parts and the dryer is designed to maintain its structural integrity through all the plant operating conditions.

8. On September 10, 2003, Entergy submitted its application to increase the maximum VY authorized power level from 1593 megawatts thermal ("MWt") to 1912 MWt. This power increase represented an increase of approximately 20% above original rated thermal power and was known as an "extended power uprate" or "EPU". Letter from J. Thayer to NRC, "Vermont Yankee Nuclear Power Station License No. DPR-28 (Docket No. 50-271) Technical Specification Proposed Change No. 263 Extended Power Uprate" (Sept. 10, 2003) ("EPU Application"), ADAMS Accession No. ML032580089.

9. In 2002, steam dryer cracking and damage to components and supports for the main steam and feedwater lines were observed at the Quad Cities Unit 2 nuclear power plant. These conditions were detected after implementation of an extended power uprate similar to the one proposed in 2003 for VY. It was determined that loose parts shed by the dryer due to flow-induced vibration had damaged the supports.

10. In response to this experience and to concerns about steam dryers at other nuclear power plants Entergy substantially modified the steam dryer at VY during the spring 2004 refueling outage to improve its capability to withstand potential adverse flow effects that could result from operation of the plant at EPU levels. The modifications, intended to increase the

structural strength of the dryer, are described in Attachment 2 to Supplement 8 (dated July 2, 2004) to the EPU Application, ADAMS Accession No. ML042090103.

### **III. VY Steam Dryer Analyses in Support of EPU**

11. In addition to making substantial physical modifications to the VY steam dryer, Entergy conducted two categories of activities to assure that the structural integrity of the dryer would be maintained during EPU operations. The first category of activities included performing two types of complementary analyses to evaluate the pressure loads acting on the steam dryer during operation at EPU conditions: the computational fluid dynamics ("CFD") and acoustic circuit model ("ACM") analyses. The calculated loads obtained from the CFD and ACM analyses were inputs to a finite element model (FEM) that calculated peak stresses for specific steam dryer locations. This FEM output was then compared to the fatigue limits for the dryer material specified in the ASME Code.

12. The resulting maximum calculated stresses for EPU conditions were found to be well within the ASME fatigue endurance limit. (The endurance limit is the level of stress that a material can withstand over an infinite number of cycles without failure.) The analyses indicated that there is significant margin between the magnitude of the potential stresses imposed on the steam dryer and the level at which fatigue failure would occur.

13. Entergy also installed 32 additional strain gages on the main steam line piping during the fall 2005 refueling outage (beyond 16 strain gages installed previously). The data measured by the strain gages and other complementary instrumentation were monitored frequently during EPU power ascension to verify that the structural limits for the steam dryer were not reached. This data monitoring was accomplished as the power levels were increased towards EPU.

### **IV. Steam Dryer Monitoring and Inspection Program During Implementation of EPU**

14. As a second set of activities intended to provide independent confirmation of the structural integrity of the steam dryer during operation at uprate levels, VY instituted a program of dryer monitoring and inspections to provide assurance that the structural loadings under EPU conditions did not result in the formation or propagation of vibration-induced cracks on the dryer. The program is described in Attachment 6 to Supplement 33 (dated September 14, 2005) to the EPU Application, ADAMS Accession No. ML052650122. The program was reviewed

and approved by the NRC and included as a license condition as part of the power uprate license amendment issued on March 2, 2006 (Exhibit 2 hereto).

15. The monitoring and inspection program measured the performance of the VY steam dryer during power ascension testing and operation as power was increased from the original licensed power level to full EPU conditions. The program included taking daily measurements of moisture carryover and periodic measurements of main steam line pressure. Pursuant to the program, following completion of EPU power ascension testing, moisture carryover measurements have continued to be made periodically, and other plant operational parameters that could be indicative of loss of steam dryer structural integrity continue to be monitored.

16. In addition to monitoring of plant operational parameters, the monitoring and inspection program calls for the steam dryer to be inspected during plant refueling outages in the fall of 2005, spring of 2007, fall of 2008, and spring of 2010. The inspections are conducted in accordance with the recommendations of General Electric's Service Information Letter ("SIL") No. 644, Revision 1 (Nov. 9, 2004), ADAMS Accession No. ML060120032 ("GE-SIL-644"). The provisions of GE-SIL-644 also govern the manner in which monitoring of plant parameters is being conducted since VY started operating at EPU levels. Plant procedures require that the periodic monitoring activities be conducted in a manner consistent with guidance in GE-SIL-644. See Exhibit 3 (VY Operating Procedure OP 0631, Appendix F).

17. The commitment to conduct dryer monitoring and inspections in accordance with the guidance of GE-SIL-644 is reflected in the above referenced license condition, proposed by Entergy in Attachment 1 to Supplement 36 to the EPU Application (October 17, 2005), ADAMS Accession No. ML052940225, and currently in effect. Entergy is committed to a program for ensuring the structural integrity of the VY steam dryer that consists of the following actions, specified in the VY operating license:

2e. Entergy Nuclear Operations, Inc. shall revise the SDMP [steam dryer monitoring program] to reflect long-term monitoring of plant parameters potentially indicative of steam dryer failure; to reflect consistency of the facility's steam dryer inspection program with General Electric Services Information Letter 644, Revision 1; and to identify the NRC Project Manager for the facility as the point of contact for providing SDMP information during power ascension.

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5. During each of the 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.

6. The results of the visual inspections of the steam dryer conducted during the 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 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.

7. The requirements of paragraph 4 above 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. If an unacceptable structural flaw (due to fatigue) is detected during the subsequent visual inspection of the steam dryer, the requirements of paragraph 4 shall extend another full operating cycle until the visual inspection standard of no new flaws/flaw growth based on visual inspection is satisfied.

8. This license condition shall expire upon satisfaction of the requirements in paragraphs 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.

Exhibit 2 hereto at 2-4.

18. As required by the VY operating license, VY is operating under a program that provides for long-term monitoring of plant parameters potentially indicative of steam dryer failure plus inspections at three consecutive refueling outages, all in accordance with GE-SIL-644. The monitoring that has been performed since implementation of the EPU, and the inspections conducted to date, confirm that fatigue-induced cracking of the VY steam dryer is not occurring.

19. To summarize, Entergy performed two categories of activities in support of its EPU Application: on the one hand, the CFD/ ACM/ FEM and the associated measurement of stress levels by means of strain gages during power ascension; this set of activities has been completed. On the other hand, Entergy instituted a monitoring and inspection program, which was initiated during power ascension, is still ongoing, and will be in effect throughout EPU operations. The monitoring and inspection program does not rely on the CFD and ACM analyses.

V. Steam dryer aging management plan for license renewal period

A. Overview

20. In its License Renewal Application, Entergy addresses aging management of the VY steam dryer as follows:

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 VYNPS's exceptions to that document.

License Renewal Application, § 3.1.2.2.11 "Cracking due to Flow-Induced Vibration."

21. GE-SIL-644 recommends that BWR licensees institute a program for the long term monitoring and inspection of their steam dryers. It provides detailed inspection and monitoring guidelines (see SIL-644, ADAMS Accession No. ML050120032, Exhibit 4 hereto, Appendices C and D). With respect to monitoring, the guidelines call for the periodic monitoring of parameters that may be indicative of steam dryer failure, particularly moisture carryover:

Moisture carryover should be monitored weekly:

Statistically evaluate the moisture carryover data and qualitatively determine if there is a significant increasing trend that cannot be explained by changes in plant operational parameters. If an unexplained increasing trend is evident, then collect additional moisture carryover data with consideration for increasing the measurement frequency (e.g., from "once per week" to "once per day").

If the latest moisture carryover measurement is greater than "mean plus 2-sigma" and this increase cannot be explained by changes in plant operational parameters, then obtain a complete set of data for the plant operational parameters (identified above). Compare the current plant operational data with the baseline data to explain the increased moisture carryover (i.e., is there steam dryer damage or not). If an increase in moisture carryover occurs immediately following a rod swap, additional moisture carryover data should be obtained to assure that an increasing trend does not exist. Note that occurrence of steam dryer damage immediately following a rod swap would be highly unlikely.

If the increasing trend of moisture carryover cannot be explained by evaluation of the plant operational data, then initiate plant-specific contingency plans for potential steam dryer damage. If the evaluation of plant data confirms that significant steam dryer damage has most likely occurred, then initiate a plant shutdown.

If there are no statistically significant changes in moisture carryover for an operating cycle, then decreasing the moisture carryover measurement frequency (e.g., from "once per week" to "once per month") may be considered, provided the highest operating power level is not significantly increased.

GE SIL-644, Rev. 1 (Nov. 2004), Appendix D at 32. As noted above, VY Operating Procedure OP 0631, Appendix F implements this guidance. This monitoring function is to continue for the balance of plant operations.

With respect to inspections, the GE guidelines establish a specific schedule for plants, like VY, that implement a power uprate:

In addition, for plants planning on increasing the operating power level above the OLTP or above the current established uprated power level (i.e., the plant has operated at the current power level for several cycles with no indication of steam dryer integrity issues), the recommendations presented in A (above) should be modified as follows:

B1. Perform a baseline visual inspection of the steam dryer at the outage prior to initial operation above the OLTP or current power level. Inspection guidelines for each dryer type are provided in Appendix C.

B2. Repeat the visual inspection of all susceptible locations of the steam dryer during each subsequent refueling outage. Continue the inspections at each refueling outage until at least two full operating cycles at the final uprated power level have been achieved. After two full operating cycles at the final uprated power level, repeat the visual inspection of all susceptible locations of the steam dryer at least once every two refueling outages. For BWR/3-style steam dryers with internal braces in the outer hood, repeat the visual inspection of all susceptible locations of the steam dryer during every refueling outage.

B3. Once structural integrity of any repairs and modifications has been demonstrated and any flaws left "as-is" have been shown to have stabilized at the final uprated power level, longer inspection intervals for these locations may be justified.

GE-SIL-644 at 7.

22. Because VY has a BWR-3 steam dryer, the details of the visual inspection program to be implemented are set forth in the corresponding section of GE SIL-644, which is Appendix C, p. 15-16. VY is implementing the above described applicable monitoring and visual inspection guidelines in GE-SIL-644.

**B. Steam Dryer Monitoring and Inspection During License Renewal Period**

23. The aging management program for the VY steam dryer during the twenty-year license renewal period will consist of well-defined monitoring and inspection activities that are defined in the GE SIL-644 guidelines and are identical to those being conducted during the current post-EPU phase. Steam dryer integrity will be monitored continuously via operator monitoring of certain plant parameters. VY Off-normal Procedure ON-3178 alerts the operators that any off the following events could be indicative of reactor internals damage and/or loose parts generation: a) sudden drop in main steam line flow >5%; b) >3 inch difference in reactor vessel water level instruments; c) sudden drop in steam dome pressure >2 psig. See Exhibit 5 hereto. In addition, periodic measurements of moisture carryover will be performed, and changes in moisture carryover will be evaluated in accordance with the requirements of GE-SIL-644. See Exhibit 3. This monitoring program will continue for the entire license renewal period. The inspection activities will include visual inspections of the steam dryer every two refueling outages consistent with GE and BWR Vessel Internals Program (VIP) requirements. The inspections will focus on areas that have been repaired, those where flaws exist, and areas that have been susceptible to cracking based on reactor operating experience throughout the industry.

24. The aging management plan for the license renewal period, consisting of the monitoring and inspection activities described above, does not depend on, or use, the CFD and ACM computer codes or the FEM conducted using those codes.

25. License Renewal Application, § 3.1.2.2.11 also commits to "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 VYNPS's exceptions to that document."

BWRVIP-139 is a 2005 industry standard developed by Electric Power Research Institute that provides steam dryer inspection and flaw evaluation guidelines. Those guidelines, currently issued in draft, are essentially the same as the ones contained in the GE SIL standard. BWRVIP-139 is currently under NRC Staff review, with an evaluation scheduled to be released in mid-2007. See <http://www.nrc.gov/about-nrc/regulatory/licensing/topical-reports/under-review.html#boiling>. If the guidelines in BWRVIP-139 are approved by the Staff, Entergy will evaluate any additional requirements that might result from the NRC's approval for applicability to VY. Any commitments made by Entergy will be consistent with the NRC regulatory requirements and guidance for aging management of plant components. VY has made a licensing commitment to "continue inspections in accordance with the Steam Dryer Monitoring Program, Revision 3 [i.e., the current inspection and monitoring program] in the event that the BWRVIP-139 is not approved prior to the period of extended operation." VY Licensing Renewal Commitment List, Commitment No. 37, Exhibit 6 hereto.

**VI. Response to issues raised by NEC**

26. NEC's consultant Dr. Joram Hopenfeld has addressed the steam dryer aging management commitment in the VY License Renewal Application as follows: "The license renewal application states at paragraph 3.1.2.2.11, and Table 3.1.2-2, that the management of cracking in the steam dryer will be in accordance with current guidance per NUREG 1801, GE-SIL-644 and possibly future guidance from BWRVIP-139, if approved by the NRC. No matter which guidance Entergy follows, the status of the existing dryer cracks must be continuously monitored and assessed by a competent engineer." Declaration of Dr. Joram Hopenfeld, dated May 12, 2006 at ¶ 19. Entergy's steam dryer aging management plan, however, does exactly what Dr. Hopenfeld requires, since it is based on continuous monitoring of plant parameters whose value is indicative of potential dryer cracking and crack propagation.

27. Dr. Hopenfeld also asserts that "Entergy's monitoring equipment does not measure crack propagation directly (because the strain gages are a distance away from the dryer) and therefore analytical tools would be required to interpret the data." Second Declaration of Joram Hopenfeld, dated June 27, 2006 at ¶ 14. The purpose of the monitoring equipment that was utilized during the EPU power ascension phase (strain gages installed on the main steam lines) was not to measure crack propagation, but to monitor pressure fluctuations in the steam piping that translate to pressure loads and ultimately to stresses on the steam dryer, to ensure that values

were below the maximum levels set by the ASME Code. The strain gages will not be used in the aging management program for the steam dryer during the license renewal period.

28. Dr. Hopenfeld also states that "Entergy has not demonstrated that the dryer will not fail and scatter loose parts in between the visual inspections, especially during design basis accidents, DBA." Id. at ¶ 15. The capability of the dryer to withstand design basis loads was demonstrated by the structural analyses and stress measurements performed as part of the EPU. It is important to note that only superficial cracks have been observed in the VY steam dryer and those cracks have not shown any measurable growth in the successive dryer inspections. Periodic visual examinations of the steam dryer in accordance with the license condition will continue to ensure that unacceptable flaw development or growth is not occurring.

29. It is also important to note that there are two types of loading imposed on the steam dryer (as well as other plant components.) There are the normal operating loads that are experienced day-in and day-out over the life of the plant. These loads are generally lower than the design basis accident loads, but because of the long time duration they can induce fatigue damage. The design basis loads are one-time loads. The purpose of the aging management process is to ensure that the condition of plant components is maintained in a status that is consistent with the design basis analyses for all plant conditions.

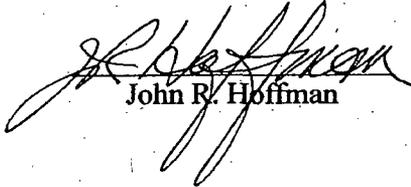
30. NEC asserts that "Entergy has previously used these computer models to establish a baseline for its steam dryer management program, and integrated code-based predictions into its aging management assessment. NEC's Contention 3 concerns regarding validity of these models are therefore current regardless of whether Entergy will make further use of them." New England Coalition, Inc's Opposition to Entergy's Request for Leave to File Motion for Reconsideration of NEC's Contention 3 (October 12, 2006) at 4. This assertion is incorrect. The purpose of the ACM and CFD analyses was to develop peak loads for the analysis of the steam dryer as a forward looking prediction that no unacceptable fatigue loadings would develop as a the power uprate was being implemented. The plant parameter monitoring and inspection program currently being conducted does not rely on the analyses performed during the implementation of the EPU and is sufficient to ensure satisfactory steam dryer performance during the license renewal period.

**VII. Summary and Conclusions**

31. My testimony in this Declaration justifies the following conclusions: (1) the steam dryer aging management plan for license renewal period proposed by Entergy is consistent with the vendor recommendations and industry guidance; (2) the monitoring and inspection activities called for in the plan are the same that the NRC has approved for assuring the structural integrity of the steam dryer during current post-EPU operation; and (3) the steam dryer aging management plan will adequately assure that the dryer's structural integrity will be maintained for all plant normal and transient operating conditions during the license renewal period.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on April 18, 2007

  
John R. Hoffman