June 30, 2009

Mr. Rick Libra
Exelon
Chairman, BWR Vessel and Internals Project
Electric Power Research Institute
3420 Hillview Avenue
Palo Alto, CA 94304-1395

SUBJECT: ACCEPTANCE REVIEW OF BOILING WATER REACTOR VESSEL AND INTERNALS PROJECT (BWRVIP)-194, "METHODOLOGY FOR DEMONSTRATING STEAM DRYER INTEGRITY FOR POWER UPRATE" (TAC NO. ME0317)

Dear Mr. Libra:

The Nuclear Regulatory Commission (NRC) staff has accepted the December 18, 2008, BWRVIP submittal, BWRVIP-194, "Methodology for Demonstrating Steam Dryer Integrity for Power Uprate." This acceptance includes consideration of your May 11, 2009, letter which removed Section 12 of BWRVIP-194 from the scope of requested review.

As described in the Enclosure to this letter, the NRC staff has determined that supplemental information will be required before detailed review can begin. A schedule for NRC review will be established after this supplemental information is provided. Additional questions may be identified as the detailed review proceeds.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 2.390, we have determined that the enclosed supplemental information request does not contain proprietary information. However, we will delay placing the supplemental information request in the public document room for a period of 10 working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects. If you believe that any information in the enclosure is proprietary, please identify such information line-by-line and define the basis pursuant to the criteria of 10 CFR 2.390.

Please inform us of your schedule for providing this supplemental information. I can be contacted at 301-415-1470, or at joseph.williams@nrc.gov if you have questions regarding this matter.

Sincerely,

/RA/

Joseph F. Williams
Senior Project Manager
Special Projects Branch
Division of Policy and Rulemaking

Project 704

Enclosure:
As stated

cc w/encl: See next page

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SUPPLEMENTAL INFORMATION REQUIRED FOR REVIEW OF
EPRI REPORT TR-1016578, OCTOBER 2008, "BWR VESSEL AND INTERNALS PROJECT, METHODOLOGY FOR DEMONSTRATING STEAM DRYER INTEGRITY FOR POWER UPRATE (BWRVIP-194)"

On December 18, 2008, the BWR Vessel and Internals Project (BWRVIP) submitted the Electric Power Research Institute (EPRI) Proprietary Report TR-1016578, October 2008, "BWR Vessel and Internals Project, Methodology for Demonstrating Steam Dryer Integrity for Power Uprate (BWRVIP-194)," for NRC staff review and approval. The NRC staff has performed an initial review and determined that supplemental information is needed to initiate its review. Specific information needs are discussed below.

1. Section 6.3.5, Table 6-4, and Section 10.1, Table 10-1: Section 5.9.2 of the topical report describes noise removal by low power subtraction. Acoustic circuit model (ACM) Revision 4 Bias and Uncertainty Values are based on benchmarking Quad Cities Unit 2 (QC2) data without low flow (LF) noise subtraction. The report should be revised to demonstrate the applicability of bias and uncertainty values established from the QC2 data without LF noise subtraction to plants where LF noise is subtracted. If these QC2 bias and uncertainty values, established without QC2 LF noise subtraction, are not conservative, then a revised set of bias and uncertainty values for application to plants where LF noise is subtracted should be provided.

2. Section 6.5.3, Evaluation of ACM Revision 4 Bias and Uncertainty: BWRVIP utilized Continuum Dynamics Incorporated ACM Revision 4 for the steam dryer analyses. Figures 6-19, 6-20, and 6-21, as well as Figures C-1 to C-16 of Appendix C, and Figures D-1 to D-16 of Appendix D of the BWRVIP-194 topical report show Power Spectral Density (PSD) plots comparing data from the instrumented QC2 steam dryer with ACM Rev. 4 predictions. The topical report also provided tables of bias and uncertainty values for specified frequency intervals as shown in Table 6-4 (Page 6-29), and Table 10-1 (Page 10-2). **[**

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3. Section 3, Overview of Steam Dryer Evaluation Approach (Page 3-4) and Section 9.4.3.2, Comparison to Allowable Range of Alternating Stress Intensity (Page 9-32): Considering all known end-to-end bias errors and uncertainties in approved extended power uprate (EPU) license amendment requests such as Hope Creek, as well as the applicable stress concentration factors, a minimum stress margin of 100% on alternating stress, or a minimum alternating stress ratio of 2, shall be maintained in steam dryer components at EPU power levels when the fluctuating pressure loads prediction on the dryer relies on main steam line (MSL) measurements. The minimum alternating stress ratio is defined as the endurance limit of the material divided by maximum alternating stress. The stress margin, as a percentage, is defined as (minimum alternating stress ratio-1) X (100). The report should be revised to state that the minimum required stress margin is 100% at EPU conditions or the minimum required alternating stress ratio in Sections 3 and 9.4.3.2 at EPU conditions is 2.0. Specifically, the Alternating Stress Ratio at EPU shall be ≥ 2.0; or Stress Margin on Alternating Stress at EPU ≥ 100%.

ENCLOSURE

4. Section 9.3.2.2 (Table 9-5, Load Combinations for Mark II and Mark III Plants, Page 9-27): Table 9-5 of BWRVIP-194 is incomplete, as faulted load combinations D-5 and D-6 for main steam line break occurring under critical initial conditions are missing. The load combination tables should be revised to provide the missing information.

5. Section 3 Overview of Steam Dryer Evaluation Approach (Page 3-4), Figure 3-1, "BWRVIP Steam Dryer Integrity Demonstration Flowchart:" The flowchart is incomplete and several steps need to be included to fully address significant evolution considerations not present in the proposed guidance. The report should be revised to address the following items:

a) Rectangular Box, right hand side, 3rd row: This block-Conduct in-plant test at Current Licensed Thermal Power (CLTP) should refer to Note 1. Note 1 should be added to the flowchart to reflect the following: If analytical screening indicates a potential for acoustic excitation, sub-scale tests or in-plant MSIV closure tests, when feasible, may be conducted.

b) Rectangular Box, right hand side, 6th row: This block-Increase in-plant CLTP Main Steam Line (MSL) pressure at each frequency by ratio of sub-scale results (power uprate/CLTP), should refer to Note 2. Note 2 should be added to the flowchart to reflect the following: At any frequency, the factor used to increase the in-plant CLTP pressures to power uprate pressures shall not be less than the ratio of flow velocity squared. At acoustic resonance frequencies, larger bump-up factors, typically much higher than the ratio of flow velocity squared, determined from sub-scale tests shall be used.

c) Diamond Box, Left hand side, 9th row, this block-Stress Margin, should refer to Note 3. Note 3 should be added to the flowchart to reflect the following: for un-instrumented steam dryers, relying on MSL measurements for steam dryer analysis, the minimum alternating stress ratio (defined as the material endurance limit to maximum calculated alternating stress in the dryer) of 2, for EPU conditions, shall be maintained.

d) Rectangular Box, right hand side, 7th row, this block-Modify/Replace Dryer, should refer to Note 4. Note 4 should be added to the flowchart to reflect the following: If steam dryers are replaced by new steam dryers, the topical report should state that the new replacement dryers shall be instrumented instead of simply relying on measurements from the MSL strain gage data to establish the structural integrity of the steam dryer for power uprate conditions.

6. Section 11.2.2, Limit Curve Generation (Page 11-3): The topical report states that in-plant CLTP strain gage data are filtered across the frequency range of interest to remove noise and extraneous signal content. The resulting PSD curve for each of the eight strain gage locations is then used to develop the limit curves, as shown in Figures 11-1 to 11-4. Level 1 limit curves are found by multiplying the main steam line pressure PSD traces by the square of the minimum alternating stress ratio.

This procedure is non-conservative because the CLTP strain gage signals would be reduced by filtering the corresponding LF signals prior to stress analysis. Therefore, the staff requests revision of the limit curve generation methodology to address this non-conservatism.

7. Sections 8.3 and 8.4, One-Eighth Scale Test: Figures 8-10, 8-23, and 8-24 show plots of bump-up factors-**[** **]** The bump-up factors that are higher than the square of flow velocities, determined from the subscale tests, **[**

] Some of the values of the bump-up factors are less than the ratio of flow velocities squared. BWRVIP is requested that the topical report include a cautionary note stating that the bump-up factor used for MSL data prediction from CLTP to EPU shall not be less than the ratio of flow velocities squared, i.e., $(V_{\text{power uprate}}/V_{\text{highest tested}})^2$.

8. Section 9.4.3.3, Finite Element Analysis Sub-Modeling at Welds, Page 9-34: The topical report presents two approaches, one formal approach, and an alternative procedure. While the formal approach is acceptable, the staff finds the alternative procedure to sub-modeling to be questionable. The staff does not endorse the alternative procedure for submodeling, where non-unique forces or displacements are applied to the submodel to reproduce the stresses. This un-conventional, non-traditional, non-standard submodeling approach is not acceptable because this method allows for a different analyst to select a different set of forces or displacement loadings and locations to reproduce the stress in the region of interest. This application of arbitrary input loadings or displacements at arbitrary locations is non-unique. The staff will not accept this alternative method unless validation is performed every time for each location where this non-traditional approach is used. The staff concludes that use of this non-conventional and submodeling approach is not advantageous. The staff requests that the topical report be revised to delete this alternative submodeling approach.

9. Section 6.3.2, Helmholtz Model formulation, Pages 6-4; 6-5: The topical report states that high resolution grid mesh is spaced 3 inches on outer top plates, outer hoods, outer portion of skirt and end plates closest to the MSLs, 6 inches on first inner top plates, first inner hoods, sections near the center of dryer, and 12 inches on rest of the inner top plates, inside hoods, center of the dryer.

Address how these spatial resolutions were established to be adequate? If the resolutions are based on sensitivity studies, provide a discussion in support of these studies.

10. Pages v, 1-2, 3-3, 9-1,9-23, 9-26, 9-27, 9-36, 4-1, 4-4, 7-1, 8-1: The BWRVIP-194 topical report references the BWRVIP-181 and BWRVIP-182 reports, which are still under NRC review and have not been accepted as yet. References to unapproved topical reports should be removed, and necessary information provided as part of the BWRVIP-194 topical report.

11. Section 9.4.3.1, Page 9-32: The BWRVIP-194 topical report addresses fatigue strength reduction factors (FSRF) for fillet welds and full penetration welds. The staff requests that the BWRVIP address the FSRF values for undersized welds and intermittent stitch welds that may be present in some dryer components.

12. Section 10.1, Page 10-2: The BWRVIP-194 topical report provides an uncertainty for accuracy of the ANSYS model solution, based on measurements from shaker tests conducted on the Hope Creek spare dryer. The uncertainty value accepted by the staff in the previous EPU applications is larger, based on measurements from shaker tests conducted on the Hope Creek spare dryer. BWRVIP is recommending a non-conservative lower uncertainty value. The

BWRVIP is requested to use the larger uncertainty value as shown in Table E-10 (Page E-78), as opposed to the uncertainty value shown in Table E-11 (Page E-78).

13. Section 9.2.4.2, Page 9-18, and Section E.5: The BWRVIP-194 topical report recommends a damping value which is larger than the value previously accepted by the NRC staff in the first application of this methodology.

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14. Section 5.3: The BWRVIP-194 topical report discusses the installation of strain gages around MSLs to define local fluctuating pressures. The BWRVIP-194 report should be revised to include a discussion on experience gained from strain gage failures due to improper installation, and cautions and recommendations to avoid such failures.

15. Section 9.1.9: In this section, the topical report briefly touches on the subject of steam dryer cracking and plant specific evaluations. The BWRVIP-194 report should be revised to address loose parts evaluations, on a plant-specific basis, as well as the potential of any degraded components, with unknown structural conditions and inaccessibility for inspection, for possibility of flutter vibrations or galloping under cross-flow. The supporting documentation should also contain an evaluation of any existing flaws in the steam dryer components and their impact on steam dryer operation at EPU conditions. A reference to Section 4.0 of the BWRVIP-06A topical report, for consideration of loose parts, and the BWRVIP-139 topical report, Steam Dryer Inspection and Flaw Evaluation Guidelines, should be incorporated into the BWRVIP-194 report.

16. Acoustic Load Mitigation, Page 3-4: In Figure 3-1 (Flowchart), the topical report mentions the installation of acoustic load mitigation measures. The BWRVIP-194 report should be revised to address various acoustic load mitigation devices such as Acoustic Side Branches on the safety relief valve standpipes, and Acoustic Vibration Suppressors for blind standpipes in steam flow path, and the required testing to establish their effectiveness in providing steam dryer stress margins at EPU conditions for plant specific applications.

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