PSEG Nuclear LLC
P.O. Box 236, Hancocks Bridge, New Jersey 08038-0236

PSEG
Nuclear LLC

10 CFR 50.90

LR-N07-0171
LCR H05-01, Rev. 1
August 3, 2007

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Hope Creek Generating Station
Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: Response to Request for Additional Information
Request for License Amendment - Extended Power Uprate

References:
1) Letter from George P. Barnes (PSEG Nuclear LLC) to USNRC, September 18, 2006
2) Letter from USNRC to William Levis (PSEG Nuclear LLC), June 7, 2007
3) Letter from George P. Barnes (PSEG Nuclear LLC) to USNRC, June 22, 2007

In Reference 1, PSEG Nuclear LLC (PSEG) requested an amendment to Facility Operating License NPF-57 and the Technical Specifications (TS) for the Hope Creek Generating Station (HCGS) to increase the maximum authorized power level to 3840 megawatts thermal (MWt).

In Reference 2, the NRC requested additional information concerning PSEG's request. PSEG provided responses in Reference 3 to the balance of plant and health physics branch questions. Attachment 1 to this letter provides responses to the remaining mechanical branch questions.

PSEG has determined that the information contained in this letter and attachments does not alter the conclusions reached in the 10CFR50.92 no significant hazards analysis previously submitted.

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NRR

Attachment 1 contains information proprietary to Continuum Dynamics, Inc. (C.D.I.). C.D.I. requests that the proprietary information in Attachment 1 be withheld from public disclosure in accordance with 10 CFR 2.390(a)(4). An affidavit supporting this request is included with Attachment 1. A non-proprietary version of PSEG's Attachment 1 responses is provided in Attachment 2.

C.D.I. Report 07-09P, Rev. 1, "Methodology to Predict Full Scale Steam Dryer Loads from In-Plant Measurements, with the Inclusion of a Low Frequency Hydrodynamic Contribution," is provided in Attachment 3 to this letter. The report includes a comparison of acoustic circuit model (ACM) predictions with pressure sensor data from the Quad Cities Unit 2 steam dryer. The report also provides the frequency-dependent bounding pressure ACM bias errors and uncertainties based on the Quad Cities Unit 2 data.

C.D.I. Report 07-18P, Rev. 0, "Acoustic and Low Frequency Hydrodynamic Loads at CLTP Power Level on Hope Creek Unit 1 Steam Dryer to 200 Hz," is provided in Attachment 4 to this letter. The report provides fluctuating pressure loads on the HCGS steam dryer based on 2007 in-plant main steam line strain gage data at current licensed thermal power (CLTP).

C.D.I. Report 07-17P, Rev. 1, "Stress Assessment of Hope Creek Unit 1 Steam Dryer Based on Revision 4 Loads Model," is provided in Attachment 5 to this letter. The report provides updated dryer stress analyses based on the loads determined from the MSL in-plant measurements. The stress analysis was performed in the frequency domain. A comparison of stress analyses in the time and frequency domains is provided in Appendix B of the report.

C.D.I. Technical Note No. 07-29P, Rev. 0, "Limit Curve Analysis with ACM Rev. 4 for Power Ascension at Hope Creek Unit 1," is provided in Attachment 6 to this letter. The document provides steam dryer limit curves based on the updated stress analysis.

C.D.I. Reports 07-09P, 07-18P and 07-17P and C.D.I. Technical Note No. 07-29P contain information which C.D.I. considers to be proprietary. C.D.I. requests that the proprietary information be withheld from public disclosure in accordance with 10 CFR 2.390(a)(4). An affidavit supporting these requests is provided in Attachments 7.

PSEG will provide non-proprietary versions of the documents in Attachments 3, 4, 5 and 6 suitable for public disclosure by August 17, 2007.

There are no regulatory commitments contained within this letter.

Should you have any questions regarding this submittal, please contact Mr. Paul Duke at 856-339-1466.

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

Executed on 8/3/07
(date)

Sincerely,

George P. Barnes

George P. Barnes
Site Vice President
Hope Creek Generating Station

Attachments
1. Response to Request for Additional Information
2. Response to Request for Additional Information (non-proprietary)
3. C.D.I. Report 07-09P
4. C.D.I. Report 07-18P
5. C.D.I. Report 07-17P
6. C.D.I. Technical Note No. 07-29P
7. Continuum Dynamics Incorporated Affidavit

cc: S. Collins, Regional Administrator – NRC Region I
J. Shea, Project Manager - USNRC
NRC Senior Resident Inspector - Hope Creek
P. Mulligan, Manager IV, NJBNE

Hope Creek Generating Station
Facility Operating License NPF-57
Docket No. 50-354

Extended Power Uprate

Response to Request for Additional Information

Hope Creek Generating Station
Facility Operating License NPF-57
Docket No. 50-354

Extended Power Uprate

Response to Request for Additional Information

In Reference 1, PSEG Nuclear LLC (PSEG) requested an amendment to Facility Operating License NPF-57 and the Technical Specifications (TS) for the Hope Creek Generating Station (HCGS) to increase the maximum authorized power level to 3840 megawatts thermal (MWt).

In Reference 2, the NRC requested additional information concerning PSEG's request. PSEG's responses to the balance of plant and health physics branch questions were provided in Reference 3. Responses to the remaining questions in Reference 2 are provided below.

14) Mechanical & Civil Engineering Br (EMCB) (additional question)

14.65 **Question deleted**, information superseded by PSEG new steam dryer data.

14.66 In regard to the PSEG response to request for additional information (RAI) 14.2, discussed in attachment 1 to the licensee submittal dated April 30, 2007, PSEG addresses RAI 14.2a by exploring the accuracy of the ANSYS finite element computer program used to compute dryer stresses. In its study, [[

]]. PSEG is requested to provide the bias error and uncertainty of the Hope Creek dryer finite element (FE) model transfer function amplitudes (RAI 14.2a). Also, the main uncertainties in the response functions of a welded, built up structure are the boundary conditions of the plating (the welds, gussets, and other joints). PSEG should elaborate on their error analysis by quantifying the accuracy of their plate joint models and the corresponding accuracy of the overall model transfer functions. Have any measurements been made on the abandoned HC2 dryer that would quantify the FE model accuracy? Also, what modeling convergence studies have been conducted to ensure the high strain and stress regions have converged meshes?

Response

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14.67 Draft question was revised as follows:

PSEG is requested to compute the frequency-dependent bounding pressure acoustic circuit model (ACM) bias errors and uncertainties based on the Quad Cities Unit 2 (QC2) data for dryer hood sensors P1-P12 which should be applied to any power ascension limits and/or limit curves. Frequency ranges are: [[

]].

Response
Frequency-dependent bounding pressure acoustic circuit model (ACM) bias errors and uncertainties based on the Quad Cities Unit 2 (QC2) data are provided in C.D.I. Report No. 07-09, Rev. 1 (Attachment 3 to this letter).

14.68 Question deleted and replaced by Q 14.67.

14.69 Question deleted and replaced by Q 14.67.

14.70 In regard to the PSEG response to RAI 14.11, discussed in attachment 1 to the licensee submittal dated April 30, 2007, PSEG states that a better comparison of scale model test (SMT) vs. plant data for the Hope Creek steam dryer is available in Continuum Dynamics Inc (CDI) Report 07-01P. Figure 4.4 of that report compares dryer pressures simulated using the ACM at two locations, based on both January 2007 in-plant data and SMT data. [[

]]. As a follow-up to this RAI, PSEG is asked to clearly define how the limit curves for the in-plant main steam line (MSL) pressure measurements are derived. Are the limit curves based on the upper bounds of the sub-scale and January 2007 MSL measurements? If any parts of the MSL limit curves are

based on SMT data which [[
]], *what bias errors and uncertainties are applied to the limit* curves? Also, provide the Hope Creek MSL limit curves for the 8 specified locations.

Response
New limit curves provided in C.D.I. Technical Note No. 07-29P (Attachment 6 to this letter) are derived from 2007 in-plant data taken at CLTP conditions. This report documents how the limit curves are defined and provides limit curves for the eight strain gage locations. See the response to RAI 14.109.

14.71 Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.72 Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.73 Draft question was revised as follows: PSEG is requested to plot the distribution of the acoustic pressure [[

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Response
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]] Figure 4.7 in C.D.I. Report No. 07-18P shows the requested plot. Also refer to section 5.4 in C.D.I. Report 07-17P (Attachment 5 to this letter).

14.74 In the response to RAI 14.19, PSEG states that during power ascension, it is planned to add accelerometers to four safety relied valves (SRVs) to monitor the vibration levels in comparison to predetermined acceptable limits. PSEG is requested to provide information regarding the acceptable limits for valve vibration, which will be implemented in the Power Ascension Test Plan.

Response
PSEG is the process of developing a finite element model of the SRVs which will allow calculating vibration limits for these valves. This effort is being done by MPR Associates, who were selected based on their experience in the evaluation of the Quad Cities relief valves. This analytical effort will benefit from the original qualification testing of these valves to benchmark resonance frequencies. The results of the MPR analysis, and the established limits, will be incorporated into the Power Ascension Test Plan.

14.75 PSEG responds to RAI 14.28 in Attachment 1 to a letter (LR-N07-0099/LCR H05-01, Rev. 1) from G. P. Barnes (PSEG) to NRC dated April 30, 2007. PSEG asserts that [[

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Response

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14.76 In response to RAI 14.29, PSEG states that there are no Hope Creek steam dryer mode shapes or frequencies to compare with the corresponding FE results. A [[

]]. Explain the simplifications made in the Hope Creek dryer FE analysis and provide justifications for these simplifications.

Response

Simplifications in the FE analysis are described in C.D.I. Report No. 07-17P, Section 3.3 (Attachment 5 to this letter). Justifications for these simplifications are provided in Sections 3.4 through 3.9.

14.77 In response to RAI 14.30, PSEG explains how the alternating weld stresses are determined for the plates of two different thicknesses welded by a fillet weld. [[

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Response

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Examples

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For completeness, the component thicknesses and putative undersize weld factors at the nodes with the three lowest maximum stress ratios and three lowest alternating stress ratios reported in Table 7b of C.D.I. Report 07-17P are listed below.

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14.78 In response to RAI 14.32, PSEG states that for the FE analyses for all different frequency shifts [[

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Response
PSEG has revised its FE analysis to a harmonic approach which is documented in C.D.I. Report No. 07-17P (Attachment 5 to this letter). This approach defines structural damping as 1% of critical damping at all frequencies.

14.79 In regard to the PSEG response to RAI 14.34, discussed in attachment 1 to the licensee submittal dated April 30, 2007, PSEG lists the model regions with the highest stresses and the corresponding peak frequencies:

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Response

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14.80 In regard to the PSEG response to RAI 14.35, discussed in attachment 1 to the licensee submittal dated April 30, 2007, [[

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<u>Response</u>
With regard to the comparisons provided in RAI 14.35:

(a) The in-plant CLTP data was based on the information from C.D.I. Report 06-24 Revision 3 which used the 2006 in-plant data. PSEG revised the CLTP FEM to reflect the 2007 in-plant data. The revised FEM is described in C.D.I. Report 07-17P (Attachment 5 to this letter)

(b) The EPU data was based on C.D.I. Report 06-27 Revision 2 which used the revised SMT EPU estimates (after rebenchmarking the SMT).

(c) New limit curves are provided based solely on the 2007 in-plant data at 100% CLTP. The new limit curves are provided in C.D.I. Technical Note 07-29P, Revision 0 (Attachment 6 to this letter).

14.81 Question deleted, requested limit curves were submitted on May 10, 2007, by the licensee.

14.82 In response to RAI 14.39, PSEG discusses vibration monitoring for EPU operation. Discuss the consideration of operating experience at QC regarding valve actuator vibration for cantilevered components.

Response

Based on a review of EPU operating experience (Reference 14.82-1), the BWROG concluded that the majority of vibration problems at the Quad Cities plants were an anomaly related to high steam velocities that produce high vibration levels (inside the steam piping). HCGS vibration levels at CLTP are reported in Attachment 8 to the EPU LCR. Vibration levels at HCGS are considered low.

The QC Electromatic Relief Valve (ERV) pilot valve is directly connected to the ERV main valve by a pilot tube that provides the inlet steam to the pilot valve, and also by a turnbuckle support that provides structural support of the pilot valve. The ERV actuator (i.e. solenoid) is cantilevered from the top of the pilot valve.

The HCGS main steam safety relief valves (SRVs) are Target Rock two-stage pilot operated SRVs. The SRV pilot valve is attached to the main valve body by a flanged connection, providing significantly more support/rigidity than a turnbuckle. The TR SRV solenoid valve is mounted on top of the pilot assembly. The solenoid does not have to override the pilot valve spring. Rather, it is used only to admit the compressed gas that provides the motive power to override the pilot valve spring. This allows the solenoid to be smaller. The solenoid valve adapter plate is attached to the TR pilot assembly using bolted connections in two axes. One attachment point (with two bolts) is under the flange and the second attachment point (also with two bolts) is on the side of the flange.

PSEG performed a susceptibility review to determine systems and components susceptible to flow induced vibration (FIV) increases at Extended Power Uprate (EPU) conditions. During the RF13 (Spring 2006) refueling outage, experienced pipe stress engineering personnel performed walkdowns and drawing reviews of impacted systems to look for vulnerable configurations. The walkdowns included the drywell, steam tunnel, feedwater heater rooms, turbine area, and reactor feed pump turbine rooms. The walkdowns did not identify any components with complex, cantilevered components mounted on the lines susceptible to higher vibration at EPU.

HCGS will instrument the SRVs and monitor them during power ascension.

References

14.82-1 BWROG NEDO-33159 "EPU Lessons Learned and Recommendations," November 2004

14.83 PSEG asserts that the Susquehanna Steam Electric Station (SSES) is similar to Hope Creek. In the 1980's, the Susquehanna steam dryers cracked due to the coincidence of localized dryer structural resonances and the tone(s) emitted from the recirculation pumps at their vane passing frequencies. SSES and GE stated that the pump tones excited the dryer not with acoustic pulsations, but through structure-borne transmission paths between the pumps and the dryer (presumably with structural vibrations entering the dryer through the dryer feet). PSEG does not account for the loading due to recirculating pump vane passing frequency in the stress analysis of the Hope Creek dryer under EPU conditions as presented in CDI Report No. 06-27. PSEG was asked in RAI 14.57 how it planned to monitor dryer loading caused by tones at the recirculation pump vane passing frequency. In regard to the PSEG response to RAI 14.57, discussed in attachment 1 to the licensee submittal dated April 30, 2007, PSEG states that GE analyzed [[

]]. PSEG is requested to demonstrate that the structure borne loads caused by recirculation pump vane passing frequency tones do not excite resonances of steam dryer components that might respond strongly and, therefore, do not need to be accounted for.

Response

SSES is similar to HCGS in a number of design aspects including the steam dryer, but there are significant additional factors that have to be considered in the SSES Unit 1 1984 failure (found after their first operating cycle). These are discussed in the paragraphs below.

The first significant difference is in the steam dryer loads. SSES has MSL dead-headed branch lines and HCGS does not. Refer to RAI 14.60 for a discussion of the impact of MSL dead-headed branch lines. It shows that SSES has significantly higher low frequency loads based on a comparison of the MSL strain gage data.

At the first SSES Unit 1 refueling outage, a fatigue induced failure was found in one of the four endplate joints for the middle hoods. This one joint was modified by adding external reinforcement strips to outside of the middle hood. After the modification was completed, the dryer was instrumented and returned to service. Data provided by the instrumentation on the SSES Unit 1 dryer confirmed the effectiveness of the modification. The other three middle hood to end plate locations did not fail, but were subsequently modified in the same manner. This suggests that weld/joint quality may have been an issue in the SSES 1984 failure.

Also, HCGS in 1985 prior to commercial operation tested and then had to adjust the height of three of the four support lug support points to ensure level support and preclude rocking of the HCGS steam dryer. The reason cited for this work was that the 1984 SSES Unit 1 inspection found one of the four steam dryer support lugs cracked. This raises the possibility that during SSES Unit 1's first cycle of operation there was uneven SSES dryer support which could have led to steam dryer rocking and increased stresses.

Per the 1985 HCGS steam dryer field work which resulted from the SSES unit 1 failure, an individual from GE, knowledgeable in the fabrication of steam dryers, inspected at HCGS the eight joints between the middle and inner hoods and their respective end plates to determine the weld quality. This occurred prior to commercial operation allowing the HCGS inspections to be done from the inside and from the outside of the joints by direct visual examination. This included inspecting the as-fabricated gap between the two components using shims and, secondly, determining the depth that the groove weld (made from the outside) penetrated into the joint. For HCGS, it was determined there was acceptable (minimal) separation between the two components. However, the inspector noted that although the groove weld depth was at least equal to the thinner component (0.125-inches), the weld was not a complete groove weld. HCGS elected to strengthen the joint from both the inside (back-welding to ensure a full groove weld) and the outside (reinforcement strips). Refer to the sketch in CDI Report 06-27 R2 Appendix A. HCGS also elected to make these changes to the four equivalent joints on the innermost hoods.

In summary, the information available to PSEG strongly suggests that there were a number of contributors to the SSES middle hood failure other than recirculation pump vane passing frequency (VPF). These include the presence of large low frequency loads, possible steam dryer "rocking", and weld-quality. Since the HCGS has not instrumented the dryer, PSEG cannot measure the VPF on the steam dryer. Due to the relative mass of the reactor vessel with respect to the recirculation system piping, it is not considered likely that the recirculation system would impose significant vibration on the reactor vessel. In addition, since the recirculation pump speed range is not being changed by EPU, the steam dryer would not be exposed to any new vane passing frequencies that have not been present in the over 20 years of operation to date. The steam dryer inspections performed to date and those that will be performed following EPU implementation are adequate to address the concern on loads imposed by the VPF.

14.84 In RAI 14.63, PSEG was asked to submit measurements made of the acoustic pressures within the reactor pressure vessel (RPV) to confirm that no strong 80 Hz tone exists in the Hope Creek reactor. In regard to the PSEG response to RAI 14.63, discussed in attachment 1 to the licensee submittal dated April 30, 2007, PSEG references Structural Integrity Associates (SIA) Report HC-31Q-301, which was attached. The SIA report explains that a dynamic pressure transducer was attached to a level sensing line in the Hope Creek RPV and pressures were measured at CLTP conditions. Figure A2b in the report shows that a resonance at 80 Hz exists in the RPV steam volume, but that its amplitude is small compared to other tones, like the high amplitude peaks at 18 Hz and near 105 Hz. The 18 Hz peak is not explained, but the 105 Hz peak is attributed to the vane passing frequency of the recirculation pumps (the potential effects of vane passing frequency tones on the steam dryer were addressed in RAI 14.57). [[

]].

Response
Refer to section 5.4 in C.D.I. Report 07-17P (Attachment 5 to this letter).

RAIs based on the revised documents submitted by PSEG

14.85 PSEG claims that data in CDI Report No. 07-01P, submitted as part of attachment 1 to the licensee submittal dated April 30, 2007, confirms that the dryer loading based on the mirrored MSL inputs from May 2006 is conservative. PSEG, therefore, states in Section 4 of Attachment 7 Rev. 1 to LR-N06-0286, LCR H05-01, Rev. 1, dated April 2007, that their original FE stress analysis of the Hope Creek dryer using dryer loads based on mirrored MSL in-plant inputs (CDI Report No. 06-24, Rev. 3, Sep 2006) is also conservative. PSEG has not conducted additional FE stress analyses using the 2007 inplant MSL measurements (without mirrored inputs). [[

]].

PSEG is requested to provide a rigorous demonstration that their 2006 stress analysis results based on mirrored MSL inputs is actually conservative, particularly for peak stresses below 60 Hz.

Response
To resolve concerns with the algorithm used to bound the 2006 partial, in-plant measurements, HCGS updated the CLTP FEM analysis using the 2007 in-plant data. The revised FEM is described in C.D.I. Report 07-17P (Attachment 5 to this letter).

14.86 PSEG discusses updated dryer stress uncertainties in Section 5.2 of Attachment 7 Rev. 1 to LR-N06-0286, LCR H05-01, Rev. 1, dated April 2007. PSEG divides the loading uncertainty into frequency and amplitude components. Dryer stresses are calculated at several time-shifted conditions, where the loads are expanded or contracted in time between +/-10% in intervals of 2.5%. The ratios between the highest computed stresses and those at the nominal (no time shift) conditions are computed and termed uncertainties. The overall loading amplitude uncertainty, based entirely on ACM uncertainties discussed in Section 4.2.1, is 27.2%. No uncertainty or bias error is associated with the FE model used to compute stresses (separate RAIs question the lack of FE model uncertainties and bias errors). PSEG then asserts that it is appropriate to combine the frequency and amplitude uncertainties by the Square Root of the Sum of the Squares (SRSS) approach to compute the overall uncertainty of the dryer stresses computed at nominal loading conditions. The SRSS approach in computing overall uncertainty is not appropriate because the increase in the stresses resulting from frequency shifts represents bias error (and not uncertainty) and, therefore, should be combined with the ACM uncertainty by absolute sum (and not SRSS). The Vermont Yankee plant, cited by PSEG in its application, reported the worst-case stresses due to frequency shifting, which were then combined with the ACM and FE model uncertainties by absolute sum approach to compute their limit curves. PSEG is requested to treat the increase in the stresses due to frequency shifts as bias error or provide rigorous justification for treating it as uncertainty.

Response
See the response to RAI 14.66. In addition, in C.D.I. Report No. 07-17P the load uncertainty (from the strain gages and ACM) is included in the load applied to the FEM. Since the stress ratios reported in the FEM for the nominal and all eight frequency shifts already include the load uncertainty, the stress ratios from the frequency shift combine the load and frequency shift errors by the absolute sum (rather than SRSS).

14.87 Question deleted, information superseded by PSEG new 2007 steam dryer data.

14.88 CDI Report 07-01, Fig. 3.4 shows that the PSDs of subscale pressure pulsations in MSLs [[

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Response

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14.89 In CDI Report 07-01, there is an apparent disagreement between the PSDs shown in [[

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Response
See the response to RAI 14.88. Low frequency has not been filtered out, because it is believed to be present in the subscale facility for the reasons given above.

b) [[
]] and

Response
The effect this has on the dryer, on nodes 7 and 99, is shown in Figure 4.4 of C.D.I. Report No. 07-01P.

c) Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.90 Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.91 Question deleted, requested CDI report was submitted on May 24, 2007, by the licensee.

14.92 Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.93 Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.94 Question deleted, due to NRC staff decision to not allow stress curves to be developed based on SMT results.

14.95 In CDI Report No. 06-16, Rev. 2, the Mach number values given in Table 8.2 [[

]].

Response
At CLTP, Hope Creek generates 14.4 Mlbm/hr of steam with a steam density of 2.24 lbm/ft^3 (pressure = 1000 psia). The total flow area of the main steam lines is 12.2 ft^2 and the acoustic speed in steam is approximately 1600 ft/sec. The CLTP Mach number is then equal to 0.0913. EPU Mach number is 1.15×0.0913 or 0.105. Hope Creek will first ascend to TPU conditions, which is a Mach number of 0.102.

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14.96 In Section 2.3, "Pressure Loading," of CDI Report 06-27, Rev. 2, the applicant describes how it selected a two-second pressure time history loading for the FE analysis. PSEG explains that for the selected time history, the pressure ranges summed over the nodes of a low-resolution grid of the dryer (including only corners and edges, a total of 104 locations) achieved a maximum steam dryer stress. The explanation is not clear. The applicant is requested to provide further explanation for how the 2-second pressure time history loading for the FE stress analysis is selected. PSEG is also requested to justify why the selection method it has used would provide the maximum stresses in the steam dryer and what may be the uncertainty associated with it.

Response
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14.97 In Appendix A of CDI Report 06-27, PSEG discusses a correction of weld fatigue factor for the multi-component weld between the inner hood and side panel. As shown in the figure of this appendix, the weld has three components: a full penetration groove-weld butt joint (Weld A), a fillet weld connecting the reinforcing strip to the plates (Weld B), and a fillet weld connecting two plates (Weld C). Please respond to the following concern:

a) This is a complex weldment for which PSEG provides a simplified analysis. It is not clear to the NRC staff whether such a simplified analysis represents the actual stress concentrations present in this weld. For example, it is not clear how the presence of Welds A and B might be affecting the stress concentration at the toe of Weld C connecting the side panel. PSEG is requested to perform a finite element analysis of this weldment to determine the actual weld fatigue factor.

Response

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b) Draft question was deleted and superseded by new question 14.108.

14.98 No question, typographical error in the Draft RAI question 14.97.

14.99 Draft question was deleted and superseded by a new question 14.108.

14.100

Question deleted and replaced by Q 14.67.

14.101

Question deleted and replaced by Q 14.67.

14.102

Question deleted and replaced by Q 14.67.

14.103

Attachment 8 to PSEG's submittal dated April 30, 2007, discusses the power ascension test plan. Provide the proposed license conditions and commitments regarding potential adverse flow effects for the power ascension. See, for example, the Vermont Yankee EPU license amendment.

Response

Proposed license conditions regarding potential adverse flow effects for the power ascension are provided below.

Proposed License Conditions

This license condition provides for monitoring, evaluating, and taking prompt action in response to potential adverse flow effects as a result of power uprate operation on plant structures, systems, and components (including verifying the continued structural integrity of the steam dryer).

1. The following requirements are placed on operation of the facility above the thermal power level of 3339 megawatts thermal (MWt):

   a. PSEG Nuclear LLC shall monitor hourly the main steam line (MSL) strain gages during power ascension above 3339 MWt for increasing pressure fluctuations in the steam lines.

   b. PSEG Nuclear LLC shall hold the facility for 24 hours at 105% and 110% of 3339 MWt to collect data from the MSL strain gages required by Condition 1.a, conduct plant inspections and walkdowns, and evaluate steam dryer performance based on these data; shall provide the evaluation to the NRC staff by facsimile or electronic transmission to the NRC project manager upon completion of the evaluation; and shall not increase power above each hold point until 96 hours after the NRC project manager confirms receipt of the transmission.

   c. If any frequency peak from the MSL strain gage data exceeds the Level 1 limit curve, PSEG Nuclear LLC shall return the facility to a power level at which the limit curve is not exceeded. PSEG Nuclear shall resolve the uncertainties in the steam dryer analysis, document the continued structural integrity of the steam dryer, and provide that documentation to the NRC staff by facsimile or electronic transmission to the NRC project manager prior to further increases in reactor power.

   d. In addition to evaluating the MSL strain gage data, PSEG Nuclear LLC shall monitor reactor pressure vessel water level instrumentation or MSL piping accelerometers on an hourly basis during power ascension above 3339 MWt. If resonance frequencies are identified as increasing above nominal levels in proportion to strain gage instrumentation data, PSEG Nuclear LLC shall stop power ascension, document the continued structural integrity of the steam dryer, and provide that documentation to the NRC staff by facsimile or electronic transmission to the NRC project manager prior to further increases in reactor power.

2. PSEG Nuclear LLC shall implement the following actions:

   a. In the event that acoustic signals are identified that challenge the limit curve during power ascension above 3339 MWt, PSEG Nuclear LLC shall evaluate dryer loads and re-establish the limit curve based on the new strain gage data, and shall perform a frequency-specific assessment of ACM uncertainty at the acoustic signal frequency.

   b. After reaching 111.5% of 3339 MWt, PSEG Nuclear LLC shall obtain measurements from the MSL strain gages and establish the steam dryer flow-induced vibration load fatigue margin for the facility, update the dryer stress report, and re-establish the limit curve with the updated ACM load definition, which will be provided to the NRC staff.

   c. After reaching 115% of 3339 MWt, PSEG Nuclear LLC shall obtain measurements from the MSL strain gages and establish the steam dryer flow-induced vibration load fatigue margin for the facility, update the dryer stress report, and re-establish the limit curve with the updated ACM load definition, which will be provided to the NRC staff.

   d. During power ascension above 3339 MWt, if an engineering evaluation is required because a Level 1 acceptance criterion is exceeded, PSEG Nuclear LLC shall perform the structural analysis to address frequency uncertainties up to ±10% and assure that peak responses that fall within this uncertainty band are addressed.

   e. PSEG Nuclear LLC shall revise plant procedures 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 BWRVIP-139; and to identify the NRC Project Manager for the facility as the point of contact for providing power ascension testing information during power ascension.

f. PSEG Nuclear LLC shall submit the final extended power uprate (EPU) steam dryer load definition for the facility to the NRC upon completion of the power ascension test program.

g. PSEG Nuclear LLC shall submit the flow-induced vibration related portions of the EPU startup test procedure to the NRC, including methodology for updating the limit curve, prior to initial power ascension above 3339 MWt.

3. PSEG Nuclear LLC shall prepare the EPU startup test procedure to include:

(a) the stress limit curve to be applied for evaluating steam dryer performance;

(b) specific hold points and their duration during EPU power ascension;

(c) activities to be accomplished during hold points;

(d) plant parameters to be monitored;

(e) inspections and walkdowns to be conducted for steam, feedwater, and condensate systems and components during the hold points;

(f) methods to be used to trend plant parameters;

(g) acceptance criteria for monitoring and trending plant parameters, and conducting the walkdowns and inspections;

(h) actions to be taken if acceptance criteria are not satisfied; and

(i) verification of the completion of commitments and planned actions specified in its application and all supplements to the application in support of the EPU license amendment request pertaining to the steam dryer prior to power increase above 3339 MWt.

PSEG Nuclear LLC shall provide the related EPU startup test procedure sections to the NRC by facsimile or electronic transmission to the NRC project manager prior to increasing power above 3339 MWt.

4. The following key attributes of the program for verifying the continued structural integrity of the steam dryer shall not be made less restrictive without prior NRC approval:

a. During initial power ascension testing above CLTP, each test plateau increment shall be approximately 5% of 3339 MWt;

b. Level 1 performance criteria; and

c. The methodology for establishing the stress spectra used for the Level 1 and Level 2 performance criteria.

Changes to other aspects of the program for verifying the continued structural integrity of the steam dryer may be made in accordance with the guidance of NEI 99-04.

5. During the first scheduled refueling outage after Cycle 15 and during the first two scheduled refueling outages after reaching full EPU conditions, a visual inspection shall be conducted of all accessible, susceptible locations of the steam dryer in accordance with BWRVIP-139 inspection guidelines.

6. The results of the visual inspections of the steam dryer shall be reported to the NRC staff within 90 days following startup from the respective refueling outage. The results of the power ascension testing to verify the continued structural integrity of the steam dryer shall be submitted to the NRC staff in a report within 60 days following the completion of all Cycle 15 power ascension testing. A supplement shall be submitted within 60 days following the completion of all EPU power ascension testing.

7. This license condition shall expire upon satisfaction of the requirements in paragraphs 5and 6 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.

14.104

PSEG bases its Level 1 (13,600 psi) and Level 2 (80% of 13,600 psi) MSL pressure PSD limit curves on a previous FE stress analysis of the Hope Creek steam dryer using loads generated with the ACM based on inputs from subscale testing at EPU conditions. [[

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Response
Limit curves are now developed following the methodology used by Vermont Yankee and are discussed in C.D.I. Technical Note No. 07-29P (Attachment 6 to this letter).

14.105
Figures 4.1 and 4.2 of CDI Technical Note No. 07-19P compare the proposed Hope Creek MSL limit curves to pressure PSDs at the MSL inlets of the Hope Creek plant at CLTP.

a) [[

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Response
This is not an issue for new limit curves in C.D.I. Technical Note No. 07-29P (Attachment 6 to this letter).

b) [[

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Response
This is not an issue for new limit curves in C.D.I. Technical Note No. 07-29P (Attachment 6 to this letter).

c) [[

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Response
This is not an issue for new limit curves in C.D.I. Technical Note No. 07-29P (Attachment 6 to this letter). Note that the minimum peak stress ratio is now 1.86 (C.D.I. Report No. 07-17P (Attachment 5 to this letter)).

d) Provide the calculated stress that could be achieved in the Hope Creek steam dryer if the 80% limit curve pressures were reached, and discuss the margin to the allowable limits.

Response
80% of 13,600 psi = 10,880 psid (Level 2 allowable). The smallest stress ratio is 1.86 (C.D.I. Report No. 07-17P), giving a maximum predicted stress of 13,600/1.86 = 7,312 psi. The margin to the Level 2 allowable is then 10,880/7,312 = 1.49.

14.106
PSEG states on page 7 of CDI Technical Note No. 07-19P that "Upon achieving TPU [Target Power Uprate] of 111.5% for the next operating cycle, PSEG may elect to perform a complete finite element calculation." Discuss the basis for not committing to perform a complete final finite element calculation.

Response
PSEG will provide a complete finite element calculation to document the steam dryer stresses based on measured, in-plant loads at the TPU (111.5% CLTP).

14.107
Compare the MSL pressure PSDs for all locations for Hope Creek at CLTP, projected EPU power levels of 111.5% of CLTP and 115% CLTP, and the QC2 values at original limiting thermal power [OLTP]. Include the 118 Hz projected increases based on SMT data, including uncertainties in the Mach number which affect those increases.

Response
These plots follow for each of the eight main steam line strain gage locations. The notation is: Quad Cities Unit 2 OLTP conditions (black); Hope Creek Unit 1 in-plant CLTP conditions (red); Hope Creek Unit 1 TPU conditions projected at 111.5% power level (blue) based on modifying the bump-up factor developed from the subscale test results at CLTP and EPU conditions; and Hope Creek

Unit 1 EPU conditions (cyan) based on the bump-up factor developed from the subscale test results at CLTP and EPU conditions.

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14.108

According to reference 4 to CDI Report 06-27, Revision 2, the fatigue strength reduction factor for the root of a fillet weld is between 3 and 4. PSEG is requested to explain why the fatigue strength reduction factors for the root of fillet welds are not considered in the stress analysis of the Hope Creek steam dryer?

Response

WRC Bulletin 432 (reference 4 to C.D.I. Report 06-27, revision 2) is one of a number of publications that provide guidance on fatigue strength reduction factors (FSRF) for fillet welds. It recommends a FSRF of 1.7 for the toe of an as-welded fillet weld subject to non-destructive surface testing (but not volumetric testing). It suggests a more conservative factor, between 3 and 4, at the root if the root is not inspected.

However, it should be noted that the referenced WRC paper also provides a counter argument to the need for more stringent criteria on the root of a fillet weld. On page 33, it states:

> Most field failures, as reported in literature, identify a surface notch (flaw) as the initiation site .... Since surface examinations directly address surface flaws, fatigue quality is more dependent on surface NDE than volumetric NDE.
>
> Two additional factors support the expectation and the fact that most failures originate on the surface. They are as follows: (1) the membrane-plus-bending stresses and the thermal stresses are normally higher on the surface than at embedded locations and (2) the free surface has less constraint than an embedded location. Low constraint allows the shear plane to be worked, distorted, and separations to be formed.

Table 7b of the HCGS FEM (C.D.I. Report 07-17P, Revision 0) shows that the bending stresses are much larger than the membrane stresses at all the limiting steam dryer locations. Thus, it is expected that the stresses at the root of a fillet weld would be significantly lower than at the toe of the weld. Allowable stress intensities were evaluated against the requirements of ASME B&PV Code Section III, subsection NG as discussed in Section 4.4 of the C.D.I. report. The HCGS FEM was done under CDI's QA program which complies with 10CFR50 appendix B requirements.

The HCGS finite element analysis, prepared by C.D.I., uses a FSRF of 1.8 for fillet welds without differentiating the toe from the root. HCGS has confirmed with GE that this is consistent with the steam dryer FEMs submitted to the NRC by GE.

All HCGS steam dryer fillet welds, and base metal adjacent to the fillet welds were subject to liquid penetrant testing of the entire length of the final weld with the exception that intermittent and tack welds were subject to 5x magnification visual inspection. Welding procedures and welding materials were procedurally controlled. This applied to both the initial fabrication and all the field modifications.

The HCGS steam dryer has been inspected in accordance with EPRI Technical Report (TR) 1011463, "BWR Vessel and Internals Project, Steam Dryer Inspection and Flaw Evaluation Guidelines (BWRVIP-139)". No weld failures due to fatigue have been identified as of the last inspection, spring 2006, which was after 19 years of commercial operation.

14.109

If in-plant data at CLTP will be used to form new dryer stress limits and MSL pressure PSD limit curves (and not SMT data), the dryer stress analyses should be updated based on MSL in-plant measurements made in 2007. Updated analyses are required since there is no conclusive way to determine whether the CLTP stresses computed with 2006 in-plant data, where the A and B MSL inputs were mirrored to the C and D MSLs are conservative. Also, the analyses must be conducted at frequency shifts between +- 10% to establish the peak stresses that will be used to establish the updated limit curves.

<u>Response</u>
The CLTP FEM is resubmitted as CDI Report 07-17P (Attachment 5 to this letter). It is based on the 2007 in-plant data. The revised CLTP FEM includes frequency shifts between -10% and + 10% at 2.5% intervals. The limit curves have been revised. C.D.I. Technical Note 07-29P (Attachment 6 to this letter) is based on the revised CLTP FEM. The new limit curves are based on the limiting frequency shift.

14.110

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<u>Response</u>

The time-based approach is compared to the harmonic-based approach in the Appendix of C.D.I. Report No. 07-17P (Attachment 5 to this letter). The comparison is very favorable.

References

1. Letter from George P. Barnes (PSEG Nuclear LLC) to USNRC, September 18, 2006
2. Letter from USNRC to William Levis (PSEG Nuclear LLC), June 7, 2007
3. Letter from George P. Barnes (PSEG Nuclear LLC) to USNRC, June 22, 2007