March 20, 2007

Mr. Britt T. McKinney
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and Chief Nuclear Officer
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Berwick, PA 18603-0467

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) - SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 (SSES 1 AND 2) - EXTENDED POWER UPRATE APPLICATION REGARDING STEAM DRYER AND FLOW EFFECTS (TAC NOS. MD3309 AND MD3310)

Dear Mr. McKinney:

In reviewing your letter dated October 11, 2006, concerning the request to increase the maximum steady-state power level at the SSES 1 and 2 from 3489 megawatts thermal (MWt) to 3952 MWt, the Nuclear Regulatory Commission (NRC) staff has determined that additional information is needed to complete its review. The NRC staff's RAI relating to the steam dryer evaluation is contained in the enclosures to this letter. Enclosure 1 includes proprietary information which is indicated in brackets and underlines. We have prepared a non-proprietary version of the RAI (Enclosure 2) that does not contain the proprietary information of Enclosure 1. These questions were discussed with your staff during a teleconference on February 15, 2007, and a closed proprietary meeting on February 27, 2007. As agreed to by your staff, we request you respond to this RAI by April 30, 2007.

If you have any questions, please contact me at 301-415-1030.

Sincerely,

/RA/

Richard V. Guzman, Senior Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-387 and 50-388

Enclosures:
1. RAI (Proprietary)
2. RAI (Non-Proprietary)

cc: See next page (w/o Enclosure 1)

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DATE	3/19/07	3/20/07	3/19/07	3/20/07

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REQUEST FOR ADDITIONAL INFORMATION

RELATING TO THE

APPLICATION FOR EXTENDED POWER UPRATE (EPU)

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 (SSES 1 AND 2)

PPL SUSQUEHANNA, LLC

DOCKET NOS. 50-387 AND 50-388

The Nuclear Regulatory Commission (NRC) staff is reviewing the request from PPL Susquehanna, LLC (PPL, the licensee) to support the application of the EPU for SSES 1 and 2. The NRC staff has determined that additional information requested below will be needed to complete its review.

1. In Attachment 10, "Steam Dryer Structural Evaluation," to the licensee's submittal dated October 11, 2006, forwarding an EPU license amendment application for SSES 1 and 2, the licensee asserts that a composite grouping of three main steam line (MSL) measurements with one from another set of three MSL measurements acquired during slow main steamline isolation valve (MSIV) closure is conservative, citing Figure 4.11. However, there appears to be several locations in the figure where the composite loading is nonconservative (e.g., node numbers 10-12, 14-17, 25-30, 42-47, 51-56, 64-71, 86-93, and 101-103). The licensee is requested to explain how this nonconservatism affects dryer stresses, particularly at the components with little margin against the American Society of Mechanical Engineers (ASME) fatigue limits.

2. In Attachment 10, Table 4-13 lists all bias errors and uncertainties associated with their dryer stress assessment approach. The bias associated with the acoustic circuit model (ACM) and the finite element (FE) models are said to be included in the licensee's "stress underprediction factor" (SUPF). However, the licensee assumes a positive bias credit of 24% for "conservatism" in the 113% original licensed thermal power (OLTP) load definition, citing Continuum Dynamics Inc. (CDI)'s report on SSES 1 and 2 steam dryer load definitions. The licensee should reconcile CDI's conclusion that the loads at 113% OLTP are conservatively biased by 24% (CDI Report 06-22, Rev. 0) with Figures 5-21 and 5-22 of GE-NE-0000-0057-4166-R1-P, which shows significant pressure load underpredictions compared to the 1985 dryer pressure measurements. The licensee is requested to explain why it does not appear to include the uncertainty and bias errors (Table 4-13 in Attachment 10) in the stress uncertainty calculations.

3. The licensee is requested to submit the limit curves for power ascension, along with the power ascension monitoring plan, for review. The plan should clearly explain how the licensee will monitor and limit the dryer excitation tones below 50 hertz (Hz), and the recirculation pump vane passing frequency tone above 100 Hz. If limit curves need to be established for sensors other than the MSL strain gages to monitor these tones, the licensee should substantiate them.

4. With regard to CDI Report 05-32, Revision 0 (March 2006), "Onset of High Frequency Flow Induced Vibration in the Main Steam Lines at Susquehanna Unit 2: A Subscale Investigation of Standpipe Behavior," the licensee is requested to:

   a. Provide results of pressure measurements performed in line A and the dead leg;

   b. Provide phase relations between measurements at different locations; and

   c. Explain the nature of the 16 Hz mode, including its mode pattern.

   d. In the conclusion section, CDI recommends that "in-plant measurements…should be sampled at a high enough digitization rate" to determine whether the acoustic response of the valve standpipe is captured. Provide the digitization rate considered sufficient and the licensee's plans to satisfy this provision.

5. The licensee is requested to provide information on the measuring system to be used on the new dryer at SSES 1 and 2, including the sampling rate of data acquisition.

6. With regard to General Electric (GE) Report GENE-0000-0054-2552-01-P (October 2006), "Test Report #1 Susquehanna Steam Electric Station, Unit 1 Scale Model Test," the licensee is requested to:

   a. Provide information on the acoustic FE study of the subscale model (or the full scale model if available) indicating whether the MSLs are included in the model (of particular interest is plant frequency range of 15 to 40 Hz); and

   b. If the MSLs are not included in the FE study, provide/explain the effect of including the MSLs on the resonance frequencies and mode shapes of the lower acoustic modes.

7. The licensee is requested to provide any available evidence which supports the assumption that pressure amplitude at low frequencies (in particular, the 15 Hz component) will continue to increase proportionally to the square of flow velocity beyond OLTP.

8. With regard to CDI Report 06-22, Revision 0 (September 2006), "Hydrodynamic Loads at OLTP, CLTP [current licensed thermal power], and 113% OLTP on Susquehanna Unit 1 Steam Dryer to 250 Hz," the licensee is requested to:

   a. Indicate which ACM model was used to predict the dryer load at SSES 1 and 2; and

   b. Explain the reason(s) for choosing the model used to predict the dryer load for SSES 1 and 2.

9. With regard to CDI 06-22, the licensee is requested to provide samples of unfiltered strain gage time signals and power spectral densities. In particular, the provided samples should include the worst case of signal to noise ratio and any other signals experiencing saturation problems or poor frequency response.

10. With regard to CDI 06-22, the licensee is requested to explain why:

    a. the [[ ]]; and

    b. the [[ ]].

11. With regard to CDI 06-22, the licensee is requested to provide the following information:

    a. Explain how the reduced flow rate through the dryer during MSIV closure affects the prediction of the dryer load at 113% OLTP power level.

    b. How this effect would be addressed in the dryer load definition?

    c. Additional information which confirms the assumption that, beyond CLTP, the low frequency dryer load will increase as a function of velocity squared.

12. With regard to CDI 06-22, the licensee is requested to provide an assessment of the effect of the MSL strain gage noise reduction on the hydrodynamic part of the ACM predicted load on the dryer.

13. With regard to CDI 06-22, the licensee is requested to explain:

    a. The reasons causing such large differences between the ACM predicted load and the in-plant measured load. The deviations between these dryer loads are particularly large at low frequencies; and

    b. How these deviations will be addressed in the stress analysis.

14. With regard to CDI 06-22, the licensee is requested to explain the basis for assuming a positive bias in the 113% OLTP load definition. The above comments suggest the bias in the load definition to be negative rather than positive.

15. With regard to CDI Report No. 05-28P, Revision 2 (October 2006), “Bounding Methodology to Predict Full Scale Steam Dryer Loads from In-Plant Measurements,” the licensee is requested to provide the following**:**

    a. An explanation of how both increasing (bounding pressure, bounding root mean square (RMS), and bounding power spectral density (PSD)) and decreasing MSL damping (bounding peak pressure) in the four new “bounding” ACMs leads to higher dryer loads.

    b. Has the licensee applied each of the new “bounding” ACM models to SSES 1 and 2? If so, which of the models matched the measurements referenced in GE MDE #199-0985-P Rev 1 (Susquehanna – 1 Steam Dryer Vibration Steady State and Transient Response – Final Report, January 1986)?

16. CDI has applied the noise reduction techniques described in Section 9 of CDI 05-28P, Rev. 2 to adjust the MSL inputs to the ACM model used for analysis of the SSES 1 and

2 steam dryer. The licensee is requested to confirm whether the same noise reduction techniques were used in Quad Cities Unit 2 calculations to validate the ACM model. If not, provide justification.

17. With regard to CDI 05-28P, CDI computes a bias error of 4% and an uncertainty of 17.6% for the bounding peak pressure model based on comparing simulated and measured pressures integrated between 130 and 157 Hz. However, Figures E.1 through E.12 show that the bounding peak pressure model underestimates loads at the strongest loading peak at 156 Hz, in some cases by nearly an order of magnitude (for pressure squared). The licensee is requested to consider the worst-case underestimates at 156 Hz and provide a revised worst-case bias error for the bounding pressure peak ACM.

18. With regard to CDI 05-28P, the licensee is requested to clarify if the ACM bias errors and uncertainties cited in this report are for raw MSL inputs, or for MSL inputs that have been adjusted using noise cancellation.

19. With regard to CDI 05-28P,CDI asserts that the Bounding Pressure ACM may be applied to any boiling-water reactor (BWR) plant with MSL velocity Mach Numbers less than 0.122 with no uncertainty or bias error (pages 21 and 72 of CDI 05-28P). However, the dominant loading mechanism in the Quad Cities plants (prior to acoustic side branch installation) was singing of the safety relief valves (SRVs) and electromatic relief valves (ERVs), which depend on parameters other than MSL flow Mach number, such as SRV and ERV standpipe dimensions. The licensee is requested to provide additional justification for CDI's assertion, given the other parameters that affect dryer loading. If additional parameters need to be considered when quantifying the accuracy of the various ACM models, bounds for those parameters should be defined.

20. With regard to GE Report GENE-0057-4166-R1-P, Revision 1 (September 2006), "Susquehanna Steam Dryer Fatigue Analysis," Section 5.3 assumes that the pressure time history for the 1985 steam dryer hood is the same as the measured time histories at its cover plate. In Figures 5-21 and 5-22, it compares the predicted pressure time histories at the 90-degree and 270-degree outer hoods with those for the 1985 cover plate and concludes the frequency content of these time histories compare reasonably well. The licensee is requested to address the following:

    a. Justify the assumption that the pressure time history for the 1985 steam dryer hood is the same as the measured time histories at its cover plate.

    b. The measured pressure time history for the 270-degree cover plate of 1985 dryer has two peaks between 90 and 100 Hz, whereas predicted time history has no peaks in this range. Also, the measured time history has a 110 Hz peak, which is not present in the predicted time history. Explain these discrepancies in the frequency comparison.

    c. Provide a comparison of pressure time history measured at both cover plates of the 1985 steam dryer with the ones predicted at the same locations so that their frequency content can be compared.

21. With regard to GENE-0057-4166-R1-P, the licensee is requested to explain the cause of the 83 Hz peak in the dryer loading shown in Figures 5.20 and 5.21.

22. With regard to GE-NE-0000-0061-0595-P-R0 (December 2006), "Susquehanna Replacement Steam Dryer Fatigue Analysis," [[

]].

23. In GENE-0057-4166-R1-P, Revision 1, it is shown that the [[

]].

24. With regard to GE-NE-0000-0061-0595-P-R0, Table 7-2, the stresses from the finite element analysis for the replacement dryer at 113% OLTP [[

]]:

a. Since the plates of different thicknesses are welded together in the replacement dryer, the licensee should explain why the stresses at the welds are not multiplied by corresponding undersized weld factors.

b. Since the stress underprediction factor [[ ]] and scale factor [[ ]] are derived from the stress results for the currently installed steam dryer, the licensee should explain why these factors with the same magnitudes are applicable to the replacement dryer having larger thicknesses for several of its components.

25. With regard to GE-NE-0000-0061-0595-P-R0, the licensee is requested to provide discussion as to how the subsequent hammer test results will validate the finite element model of the replacement dryer.

26. With regard to GE-NE-0000-0061-0595-P-R0, the licensee is requested to provide natural frequencies of the dryer components and the pump vane bypass frequency at 120% OLTP. If any component experiences a resonance with the pump bypass frequency, the licensee should explain how the resulting stresses are addressed in the fatigue evaluation of that component.

27. In GE Report GENE-0057-4166-R1-P, Revision 1, the licensee provides the frequency content of the dryer stresses at key locations (Figures 8-3 and 8-7). The plots show the frequencies that dominate the dryer stresses. The licensee is requested to submit similar plots for the revised dryer at the locations [[
]].

28. With regard to the licensee's submittal dated December 4, 2006, responding to NRC staff acceptance review comments, the licensee is requested to reassess the methodology of determining its "stress underprediction factor" (SUPF). Referring to the plant measurements in 1985, the licensee should review the low frequency excitations (15, 24, and 32 Hz) at all critical locations on the dryer and compare these measurements with the load predicted by ACM. The licensee should demonstrate that the SUPF is conservative for all EPU power levels (i.e., 100 to 120% OLTP) at all critical locations on the dryer where low frequency excitations are predicted.

29. With regard to the licensee's submittal dated December 4, 2006, responding to NRC staff acceptance review comments, the licensee is requested to submit its instrumentation plan for the replacement SSES 1 and 2 steam dryer for review. The plan should show where pressure transducers will be mounted to the dryer, and how the pressure measurements will be used to assess dryer loading at the critical frequencies of 15, 24, and 32 Hz. The plan should further explain how dryer loading not correctly estimated by ACM analysis would be computed based on instrumented dryer results. The plan should also show where strain gages and accelerometer will be mounted to the dryer, and how they will be used to (a) assess the strength of the loading induced by the vane passing frequency of the recirculation pump (near 100 Hz), and (b) the end-to-end adequacy of their dryer stress simulation procedure. If the licensee determines that limit curves need to be specified for dryer instrumentation (since the dryer excitation under 50 Hz and at the recirculation pump vane passing frequency are not measured well by MSL strain gages), the licensee should submit them, and their bases, for review.

30. With regard to the licensee's submittal dated December 4, 2006, responding to NRC staff acceptance review comments, the licensee is requested to address the following:

    a. Does the vane passing frequency tone (about 110 Hz at OLTP) caused by the recirculation pump still exist at SSES 1 and 2? If so, the licensee should explain how it will be monitored since it does not appear in the MSL strain gage measurements applied to the ACM.

    b. If the recirculation pump vane passing frequency tone still exists at SSES 1 and 2, the licensee should explain how its amplitude and frequency will change between CLTP and EPU conditions. Figures 2 and 3 of Attachment 1 to the December 4 submittal show the tone's strength increasing significantly between 90% and 100% OLTP.

    c. The licensee states that localized dryer resonances near the recirculation pump vane passing frequency amplified the tone in the 1985 strain gage dryer measurements. The licensee should explain whether there are any resonances in the modified dryer that the licensee proposes to install in the Susquehanna units that might coincide

with the recirculation pump vane passing frequency as the licensee increments Susquehanna power between CLTP and EPU. If there are, the licensee should provide a list of dryer resonances and corresponding mode shapes for review, and estimate how strongly those modes might be excited by the pump tones at EPU conditions.

31. With regard to the licensee's submittal dated December 4, 2006, responding to NRC staff acceptance review comments, the licensee is requested to provide an explanation of the sources of the low frequency tones (15, 24, and 32 Hz) that appear in the original steam dryer loading measured in 1985. Specifically:

a. What excites these frequencies (such as flow within the reactor pressure vessel, or flow in the MSLs passing over the mouths of the dead legs)? If flow over the dead leg openings is responsible, the licensee should explain the estimates for the Strouhal Numbers of the instabilities over the dead leg mouths, and how the instabilities will behave at EPU conditions.

b. What is resonating? If the acoustic modes within the dead legs are resonating, the licensee should quantify their behavior.

c. Provide a clear schematic of the dimensions of the MSLs, the dead legs, and the location of the MSL strain gages with respect to the dead leg piping.

d. How will the flow excitation and resonance response change between CLTP and EPU conditions? How will the licensee monitor these changes with methods other than MSL strain gage measurements and ACM simulations?

Susquehanna Steam Electric Station, Unit Nos. 1 and 2

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