REQUEST FOR ADDITIONAL INFORMATION

REGARDING PROPOSED LICENSE AMENDMENT

EXTENDED POWER UPRATE

EXELON GENERATION COMPANY, LLC

PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-277 AND 50-278

Proprietary information pursuant to
Title 10 of the *Code of Federal Regulations* (10 CFR) Section 2.390
has been redacted from this document.
Redacted information is identified by blank space enclosed within double brackets
as shown here [[ ]].

Enclosure 2

REQUEST FOR ADDITIONAL INFORMATION

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EXTENDED POWER UPRATE

EXELON GENERATION COMPANY, LLC

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By letter dated September 28, 2012, as supplemented by letters dated February 15, 2013, May 7, 2013, May 24, 2013, June 4, 2013, June 27, 2013, July 30, 2013, July 31, 2013, August 5, 2013, August 22, 2013, August 29, 2013, and September 13, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML122860201, ML13051A032, ML13129A143, ML13149A145, ML13156A368, ML13182A025, ML13211A457, ML13213A285, ML13217A431, ML13240A002, ML13241A418, and ML13260A076, respectively), Exelon Generation Company, LLC (Exelon, the licensee) submitted a license amendment request for Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3. The proposed amendment would authorize an increase in the maximum power level from 3514 megawatts thermal (MWt) to 3951 MWt. The requested change, referred to as an extended power uprate (EPU), represents an increase of approximately 12.4 percent above the current licensed thermal power level (CLTP).

The Nuclear Regulatory Commission (NRC) staff is reviewing your submittal and has determined that additional information is needed to complete its review. The specific request for additional information (RAI) is addressed below.

Mechanical and Civil Engineering Branch (EMCB)
Reviewer: Chakrapani Basavaraju

EMCB-SD-RAI-1

Section 7.4 of WCAP-17609-P[1], "Peach Bottom Units 2 and 3 Replacement Steam Dryer Structural Evaluation for High Cycle Acoustic Loads," describes the use of submodeling for [[ ]] the PBAPS Unit 2 Replacement Steam Dryer (RSD). The NRC staff requests the following information in order to evaluate the stress analysis of the localized regions of high stress using the aforementioned submodeling technique:

[1] WCAP-17609-P, which is a proprietary document, is included as Enclosure 17B.2 to Attachment 17 of the licensee's application dated September 28, 2012. A publicly available version of this document is included as Enclosure 15B.2 to Attachment 15 of the application.

a) Describe how the size of the submodel was determined.

b) Describe how the boundary conditions and the loads acting on the submodel were determined.

c) For [[ ]], please provide a comparison of stresses (maximum stress and maximum alternating stress intensity) obtained from the global and submodel analyses, as a function of mesh size. To ensure that the cut-boundary conditions are correctly applied, analyze each submodel with the same mesh size and geometry used in the global model and compare the results with those from the global analysis.

d) Provide the justifications for any assumptions made regarding the submodel analyses.

EMCB-SD-RAI-2

Section 7.4 of WCAP-17609-P states the following:

[[

]]

The [[ ]] as presented in the excerpt above, is not clear. Please provide a more detailed explanation regarding the aforementioned [[ ]] and provide at least one example.

EMCB-SD-RAI-3

Section 3.2 of WCAP-17609-P indicates that the PBAPS RSDs are supported at four support points on the support lugs. The dryer is restrained [[ ]] and is free to expand in the radial direction. Please provide the radial displacement of the dryer support points at EPU and confirm whether the radial gaps between the dryer and the support lugs are closed at EPU. If the radial gap is closed, please explain how such closure is taken into account in the dynamic analysis of the dryer.

EMCB-SD-RAI-4

During recent EPU reviews, the NRC staff has encountered an issue regarding significant bias errors in the main steam line (MSL) strain gage array overall voltage to pressure conversion factors, leading to underestimates of the internal MSL acoustic pressures. Based on this experience, please discuss the MSL strain gage array voltage to pressure conversion factors for PBAPS plant (static) pressurization conditions along with the voltage to pressure conversion factors currently being assumed. Account for any MSL strain gage conversion factor bias errors in the fluctuating dynamic pressure loading on the steam dryer.

If the determination of the MSL strain gage voltage to pressure conversion factor bias errors as requested is not feasible, the NRC staff requests the following information. Since Exelon plans to apply end-to-end bias and uncertainty determined from PBAPS Unit 2 to the predictions for

Unit 3, the gage conversion factors for the installed MSL strain gages at both units need to be the same. Please explain how Exelon will demonstrate that the gage voltage to pressure conversion factors, for the installed MSL strain gages at both units, are the same.

EMCB-SD-RAI-5

Question deleted following audit on September 12, 2013. No response required.

EMCB-SD-RAI-6

In Section 3.1.2 of WCAP-17609-P, the use of the [[ ]] is discussed in the context of connecting shell and solid elements. In some EPU applications, the use of [[ ]] has produced conservative results (as compared with the corresponding submodel (developed using only solid elements) results), whereas in other applications it has produced non-conservative results. Please evaluate the use of [[ ]] at several high stress locations by comparing the results with the corresponding submodel results. Also, provide a background on the [[ ]] and a detailed example of its use in the dynamic analysis of the PBAPS RSDs.

EMCB-SD-RAI-7

Based on the review of the information provided in the enclosures contained in Attachment 17 to the application dated September 28, 2012, the NRC staff was unable to locate the information regarding how the stresses at the RSD welds (i.e., full penetration, partial penetration, and fillet welds) are calculated. Please describe how these stresses are calculated. State how the calculated weld stresses for the PBAPS RSDs compare with the weld stresses calculated in accordance with the approach recommended in American Society of Mechanical Engineers (ASME) Subsection NG, "Core Support Structures," based on the use of nominal stresses.

EMCB-SD-RAI-8

For PBAPS Units 2 and 3, please provide the following for the 10 lowest alternating stress ratio locations:

a) Frequency spectra for maximum alternating stresses; and

b) Stress accumulation plots (root mean square (RMS) stress as a function of increasing frequency).

Please explain whether any other information (e.g., magnitude of stress as a function of frequency) besides the frequency content of stress may be derived from the plots. Based on the plots, discuss the relative importance of the various forcing functions (e.g., valve resonances, broad-band acoustic pulsations) on the RSD alternating stresses.

EMCB-SD-RAI-9

Question deleted following audit on September 12, 2013. No response required.

EMCB-SD-RAI-10

In the Executive Summary in WCAP-17611-P, it states that the [[

]] The resonances of both valves are excited by the first shear layer mode, which is known to be a strong excitation source; this is similar to the acoustic resonances and subsequent steam dryer degradation experienced at Quad Cities Nuclear Power Station Unit 2 (QC2). In addition, the Target Rock SRV is expected to start resonance before CLTP conditions, which is, again, similar to the QC2 valve resonance. The scale model tests (SMTs) do not seem to replicate the PBAPS Units 2 and 3 plant data at CLTP. Although in-plant MSL measurements were performed at several power levels up to CLTP, you do not discuss the evolution of the standpipe resonance behavior with the power level. To develop more appropriate bump-up factors for EPU MSL signal estimates, please submit the following:

a) Power-spectral densities (PSDs) of in-plant MSL measurements at 80 percent, 85 percent, 90 percent, 95 percent, 97 percent, and 100 percent of CLTP. The PSDs provided as part of this response should be clearly labeled.

b) In-plant data trends related to pressure RMS amplitude for the total PSD and for individual resonance peaks of the aforementioned safety valves and blind flanges. In trending the amplitudes of the resonance peaks, the integration frequency range must be sufficiently narrow and centered at the resonance frequency so that the broadband noise does not affect the trends (i.e., it does not artificially reduce growth rate of the resonance peaks).

c) For each standpipe resonance frequency, please provide a plot of dimensionless pressure in the MSLs (i.e., $P_{rms}/ \frac{1}{2} \rho V^2$) against the reduced velocity in the MSL (i.e., $V/f_r D$). In these dimensionless forms, all parameters refer to the MSLs data (e.g. P_{rms} is the RMS amplitude of acoustic pressure, V and ρ are the steam velocity and density, f_r is the standpipe resonance frequency, and D is the standpipe diameter).

d) Provide data and plots from SMT, similar to those described in item (c), above.

e) Provide data and plots from in-plant measurements obtained from QC2, similar to those described in item (c), above.

f) Compare the trends of the data obtained in items (c) through (e), above.

g) Explain the method used to develop conservative bump-up factors for the SRV resonance peaks from CLTP to EPU conditions.

EMCB-SD-RAI-11

In Section 4.1 of WCAP 17611-P, the licensee indicates that [[

]]. Based on previous EPU license amendment request reviews, the NRC staff noticed that the tank pressure during this measurement period decreases from 190 psig to approximately 130 psig. The resulting decrease in the fluid density at the standpipes along the MSLs is expected to reduce the flow energy (i.e., the dynamic head) exciting the resonances in

the standpipes. Please explain how this effect is accounted for in correcting the pressure spectra obtained over the [[ ]] period of measurement.

EMCB-SD-RAI-12

Although the MSLs at PBAPS contain dead-leg pipes on MSLs B and C, the licensee does not discuss the effect of the low frequency acoustic modes of these pipes on the RSD load definition. Therefore, you are requested to:

a) Provide the frequencies of the lowest acoustic modes of the dead-leg pipes.

b) Discuss whether the response of these modes was observed in the in-plant measurements or the SMT results.

c) Explain the effect of these acoustic modes on the RSD acoustic loading.

EMCB-SD-RAI-13

The simulated dryer loading at 102 percent of the EPU power level are presented in Table 3-5 and Figures 3-2 through 3-5 of WCAP-17590-P[2], "Peach Bottom Units 2 & 3 Replacement Steam Dryer Acoustic Load Definition." These figures and table display considerable differences between PBAPS Units 2 and 3, although these units are supposed to be identical and have similar specific bias and uncertainties, as listed in Table 3-3. Please explain the sources of these relatively large differences in the total RMS differential pressure (Table 3-5) and the broadband excitation at low and high frequencies, especially on the dryer quadrants A and C. Provide contour plots of the differential pressures on the dryers of PBAPS 2 and 3 over all four quadrants for: (a) all signals between 0 and 250 Hz; (b) signals between 0 and 60 Hz; (c) signals spanning the SRV resonance near 130 Hz; and (d) signals spanning the blind flange resonance near 220 Hz. These plots should use a common contour color scale so that the plots may be easily compared. Also, provide overlays of the PBAPS 2 and 3 raw and filtered MSL spectra for all eight locations (e.g., plot PBAPS 2 versus PBAPS 3 MSL location 1 unfiltered, PBAPS 2 versus PBAPS 3 MSL location 1 filtered, PBAPS 2 versus PBAPS 3 MSL location 2 unfiltered, etc.). Additionally, overlay the monopole and dipole terms for PBAPS 2 and 3 for each MSL inlet. Interpret this information to explain the differences in loading between PBAPS 2 and 3.

EMCB-SD-RAI-14

In the course of the review of the enclosures to Attachment 17 to the application dated September 28, 2012, the NRC staff has noted several references to the Boiling Water Reactor Vessels and Internals Project (BWRVIP)-194, "Methodologies for Demonstrating Steam Dryer Integrity for Power Uprate," report. Since this report has not yet been approved for use by the NRC staff, please extract the relevant information from BWRVIP-194 used to support the PBAPS EPU amendment request, and provide a summary of the information used from the report.

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[2] WCAP-17590-P, which is a proprietary document, is included as Enclosure 17B.1 to Attachment 17 of the licensee's application dated September 28, 2012. A publicly available version of this document is included as Enclosure 15B.1 to Attachment 15 of the application.

EMCB-SD-RAI-15

In Attachment 9 to the licensee's letter dated February 15, 2013, it is noted that the bias and uncertainty associated with the structural finite element dynamic modeling of the dryers is primarily associated with modeling procedures such as the use of shell elements, the element spacing, and coupling of shell and solid modeling sections. It is indicated that you use a procedure similar to that used for the [[ ]] steam dryer model, with the exception of using [[ ]] instead of shells embedded within solids to connect different sections. You also cite internal studies showing the use of [[ ]] actually reduces uncertainty slightly, but does not take credit for this in the PBAPS EPU application. You point out that on-dryer measurements are planned to confirm the "...conservatism in the predicted ACM 4.1 results prior to exceeding CLTP." Based on the above, the NRC staff requests the following information regarding this subject:

Please submit a detailed instrumentation and measurement plan to measure natural frequencies and mode shapes, pressures acting on the dryer, and the dryer strains and accelerations to confirm that the dryer stresses are within acceptable limits. This plan should include how the measurement locations are relevant to the high loading and stress regions in the dryer and a priori predictions of the expected strain and pressure spectra and peak/rms values. You should consider ensuring that both the upper dryer, including the different hood sections, and the lower dryer (skirt) are sufficiently instrumented.