Attachment 2

Peach Bottom Atomic Power Station Units 2 and 3

NRC Docket Nos. 50-277 and 50-278

<u>Response to Request for Additional Information - SNPB</u>

Response to Request for Additional Information

Performance and Code Review Branch

By letter dated September 28, 2012, Exelon Generation Company, LLC (EGC) 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.

The NRC staff reviewed the information supporting the proposed amendment and by letter dated July 3, 2013 (NRC Accession No. ML13183A199) requested information to clarify the submittal. The response to that request is provided below.

Note – References cited in the responses are compiled in a listing behind the response to SNPB RAI-13. An acronym listing is provided following the References.

SNPB RAI-1

Please provide responses to the questions listed below regarding the type(s) of fuel used in the PBAPS, Units 2 and 3, cores during the previous and current cycles of operation.

a. Section 2.8.1 of the Power Uprate Safety Analysis Report (PUSAR[4]) indicates that both PBAPS units "plan" to transition to GNF2 fuel. Do the current cores in PBAPS, Units 2 and 3, have mixed cores? If so, specify the types of fuel in the mixed core.

b. Specify when the two units transitioned to use of GE-Hitachi Nuclear Energy (GEH) GNF2 fuel.

c. Provide a summary of the analyses that supported the introduction of GNF2 fuel.

d. Sections 2.8.2.4.6 and 2.8.2.4.7 of the PUSAR indicate that there will not be mixed cores following implementation of the proposed EPU. However, Section 2.8.1 seems to indicate there may be different "fuel types through EPU implementation." Specify whether the uprated PBAPS cores will have mixed cores. Also provide a description of the methods that will be used to assure the uprate fuel limits are satisfied.

[4] A proprietary (i.e., non-publicly available) version of the PUSAR is contained in Attachment 6 to the application dated September 28, 2012. A non-proprietary (i.e., publicly available) version of the PUSAR is contained in Attachment 4 to the application dated September 28, 2012.

RESPONSE

Response to SNPB RAI-1a:

Table 1-1 details the fuel types used by PBAPS Units 2 and 3 during the previous cycles, current cycles (U2 C20 and U3 C19), and the first EPU cycles.

Table 1-1
PBAPS Core Composition

	Unit 2		Unit 3		Power
Cycle	GE14	GNF2	GE14	GNF2	(MWth)
18	764	0	760	4*	3,514
19	492	272	494	270	3,514
20	204	560	224**	540**	3,514
21	0**	764**	0**	764**	3,951**

* U3 C18 contained 4 LUAs (Lead Use Assemblies)
** Planned

A mixed core is defined in the NRC SER for the GEH IMLTR (Reference 4, SER Section 8.2) as a "mixed fuel vendor core" or a core with "fuel type characteristics not covered in this [the IMLTR] review". This is reiterated in Appendix A of the PUSAR. PUSAR Section 2.8.1 affirms that the PBAPS EPU utilizes "only GEH/GNF fuel types" which satisfies the requirement for no other fuel vendor and PUSAR Section 2.8.2.4.6 confirms that the mixed fuel vendor core limitation does not apply. In addition, the IMLTR Supplement 3 SER (Reference 4) confirms the GNF2 fuel type is covered by the IMLTR review; therefore, the limitation regarding fuel type characteristics covered by the IMLTR review is confirmed to be satisfied as described in PUSAR Section 2.8.2.4.7.

As shown in Table 1-1, the current cores consist of GEH/GNF fuel types, and they consist of GE14 and GNF2 fuel covered by the IMLTR. Therefore, the current cores are not mixed cores.

Response to SNPB RAI-1b:

Table 1-1 shows that the GNF2 new fuel introductions were complete before C19 (U2 in 2010 and U3 in 2011) startup at both units.

Response to SNPB RAI-1c:

The NRC Safety Evaluation for the GEH Constant Pressure Power Uprate Licensing Topical Report (NEDC-33004P-A, Reference 2, the CLTR) states: "Licensees proposing to reference this LTR as a basis for a power uprate license amendment request, and also proposing to obtain a license amendment to incorporate … [[

]], must first request and obtain a license amendment for the associated change prior to the start of the staff review of the power uprate." The PBAPS EPU LAR was submitted [[

]] This NRC-approved process, outlined in NEDE-24011P-A (Reference 5) includes the [[

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Response to SNPB RAI-1d:

The response to SNBP RAI-1a describes the IMLTR mixed-core definition. Per that definition, neither the representative equilibrium core analyzed for the EPU nor the future PBAPS C21 EPU cores are mixed cores.

Future EPU cycles will ensure that all fuel limits are satisfied via the NEDE-24011P-A (Reference 5) reload process, and this reliance upon the reload process is described within the CLTR (Reference 2) and the ELTR1 (Reference 3).

SNPB RAI-2

It is stated in Section 1.1 of the PUSAR that "fuel-dependent topics" follow ELTR1[5]. In Section 1.1.1 of the PUSAR it is stated that for generic assessments that are "GNF2 fuel design dependent" the assessments contained in ELTR1 and ELTR2[6] are applicable. Please clarify what is meant by the two statements.

RESPONSE

PUSAR Section 1.1 (Reference 1) describes the report's specific approach for the PBAPS EPU LAR. Only ELTR1 (Reference 3) is referenced because ELTR1 provides guidelines and scope (or approach) for the GEH BWR EPU program.

PUSAR Section 1.1.1 provides an overview of the generic assessments performed for the GEH BWR EPU program. Since ELTR1 and ELTR2 (Reference 6) both provide generic assessments, PUSAR Section 1.1.1 references both documents.

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[5] ELTR1 refers to General Electric (GE) Licensing Topical Report (LTR) NEDC-32424P-A, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate."
[6] ELTR2 refers to GE LTR NEDC-32523P-A, "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate."

ELTR1 and ELTR2 are used together to provide an efficient process for the licensee to evaluate and submit to the NRC the necessary information for EPU approval. ELTR1 provides the proposed guidelines and scope, while ELTR2, and its supplements, are supplied to provide the maximum number of generic evaluations for the GEH BWR EPU program. The relationship between ELTR1 and ELTR2 is summarized within the ELTR2 SER Section 1.0 as:

> "The BWR extended power uprate program was initially introduced in the GE licensing topical report NEDC 32424P, "Generic Guidelines for General Electric Boiling Water Reactor Uprate," (Ref. 4) in February 1995. This licensing topical report is known as ELTR1. The NRC staff has previously reviewed and approved ELTR1 in a staff position paper dated February 8, 1996 (Ref. 5). References 4 and 5 proved guidance to licensees on the scope and content of information to be submitted as part of a plant-specific power uprate submittal. ELTR2, with the staff's endorsement, is intended for use in conjunction with ELTR1 and requisite plant-specific information in the assessment of a licensee's request for an extended power uprate."

Additionally, CLTR SER Section 1.2.1 (Reference 2) describes the ties between ELTR1 and ELTR2, and also describes their relationship with the CLTR:

> "In general, the generic system and equipment performance analyses and the generic transient and accident analyses documented in ELTR1 and ELTR2 are applicable to the CPPU approach. Exceptions and deviations to generic ELTR1 and ELTR2 conclusions are identified in individual section of the CLTR and are evaluated in the corresponding sections of this SE."

Note for SNPB RAI-2 response: In the above quotation from the ELTR2 SER, References 4 and 5 are to ELTR1 and an NRC letter to GEH, "Staff Position Concerning GE BWR Extended Power Uprate Program," dated February 8, 1996, respectively.

SNPB RAI-3

Section 1.2.3 of the PUSAR states "Reactor Core and Fuel Performance: Specific analyses required for EPU have been performed for a representative fuel cycle with the reactor core operating at EPU conditions." Please provide a summary of these analyses and denote which will be performed on a cycle-specific basis.

RESPONSE

The specific analyses required for the PBAPS EPU LAR are documented within PUSAR Sections 2.8.1 through 2.8.5 (Reference 1):

- Section 2.8.1 identifies the fuel type to be used in the EPU core and notes that the fuel design limits will be met in accordance with the approved methodology for core reload design process (i.e., GESTAR-II, Reference 5).

- Section 2.8.2 describes the EPU impact upon the thermal limits, thermal margin monitoring threshold, power and flow dependent limits, reactivity characteristics (e.g., hot excess reactivity and shutdown margin), and additional core-related topics prescribed by the IMLTR (Reference 4). Cycle-specific values for these parameters will be [[ ]]

- Section 2.8.3 defines the EPU impact upon core stability and in particular the setpoints and backup stability protection that implement the Option III stability solution used at PBAPS. Cycle-specific setpoints [[ ]]

- Section 2.8.4 focuses upon the emergency systems and components, including control blades, overpressure protection (i.e., safety relief valves), RCIC, RHR, and SLCS. The overpressure protection analysis is also performed with each cycle-specific reload analysis.

- Section 2.8.5 describes the accident and transient analyses, including AOOs, LOCA, and ATWS, considered in the evaluation of the EPU for PBAPS.

For future cycles, various analyses will be performed to confirm operating limits, and to demonstrate acceptable accident and transient response in accordance with the standard reload core design process as presented in NEDC-24011P-A (Reference 5). The analyses performed on a cycle-specific basis are outlined in the United States supplement to NEDE-24011P-A (Reference 5) in Sections S.1 through S.5.

SNPB RAI-4

Section 2.8.1 of the PUSAR states that “[t]he EPU evaluations assume a reference equilibrium core of GNF2 fuel. GNF2 fuel is resident in the PBAPS core. The fuel design limits are established for all new fuel product line designs as a part of the fuel introduction and reload analyses.” The PUSAR then makes a statement concerning fuel product line designs and further states that “[a]t the CLTP [current licensed thermal power] as well as at the EPU RTP [rated thermal power] conditions, all fuel design limits will be met through fuel bundle and core design combined with plant operational strategies. However, revised loading patterns, larger batch sizes and potentially new fuel designs may be used to provide additional operating flexibility and maintain fuel cycle length.”

Provide clarification to the statement above as to what is meant by "revised loading patterns, larger batch sizes and potentially new fuel designs may be used to provide additional operating flexibility and maintain fuel cycle length."

RESPONSE

Because cycle-specific reload core designs (for either uprated or non-uprated cores) do not exist until approximately six months before cycle operation, PUSAR Section 2.8.1 (Reference 1) is [[ ]] describing techniques which may be used to generate fuel and core designs that satisfy all safety limits and corporate generation goals.

The CLTR (Reference 2) also describes these [[ ]] This standard reload analysis process is outlined in GESTAR-II (Reference 5).

Core reload design must consider several factors. In addition to meeting fuel design limits and establishing safe operating limits, core design also addresses corporate generation goals and the optimization of the use of the energy available in a core. Even given the selection of a fuel type (e.g., GNF2), the design [[ ]] are also considered in the core design process.

The statement that "…all fuel design limits will be met through fuel bundle and core design combined with plant operational strategies" is a reflection of the fact that all requisite design limits must be met in order to operate a plant consistent with the GESTAR-II methodology. The statement "…revised loading patterns, larger batch sizes and potentially new fuel designs may be used to provide additional operating flexibility and maintain fuel cycle length" provides examples of those aspects of the reload design that can be used to address corporate generation goals.

SNPB RAI-5

Section 2.8.2 of the PUSAR briefly describes the core design process. This section states, in part, that:

The additional energy requirements for power uprate are met by an increase in bundle enrichment, an increase in the reload fuel batch size, and/or changes in fuel loading pattern to maintain the desired plant operating cycle length. The power distribution in the core is changed to achieve increased core power, while limiting the minimum critical power ratio (MCPR), maximum linear heat generation rate (MLHGR), and maximum average planar linear heat generation rate (MAPLHGR) in any individual fuel bundle to be within limits as defined in the COLR [core operating limits report].

General Design Criterion (GDC) 10 of Appendix A to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 requires the reactor core and associated coolant, control and protection systems to be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). Please provide further details on the planned: (a) increase in bundle enrichment; (b) increase in the reload fuel batch size; (c) changes in fuel loading patterns; and (d) changes in power distribution. Specifically, provide information to demonstrate that the planned changes will continue to meet the requirements in GDC-10.

RESPONSE

A cycle-specific core design is not established until approximately six months before cycle operation. Therefore, changes in enrichment, batch size, loading patterns, and power distribution for the actual EPU core designs do not yet exist. To accommodate this schedule, EPU applicants who plan to utilize GNF2 fuel, including PBAPS, take a two-fold approach: 1) [[

]]
(Reference 5). This NRC-approved approach to [[ ]] assures that the requisite limits are met during the design process.

CLTR SER Section 1.4 (Reference 2) describes application of 10 CFR 50 Appendix A to the staff's review of core and fuel performance. The results presented in PUSAR Sections 2.8.1 through 2.8.5 demonstrate conformance to the 10 CFR 50 Appendix A General Design Criteria (GDC) for the representative EPU equilibrium core.

For future reloads, the GDC will [[

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SNPB RAI-6

Describe the analysis procedure used to ensure that the shutdown margin is within the Technical Specification limit throughout the transition and equilibrium cycles of EPU operation. Specifically, describe how the eigenvalue biases and uncertainties are determined and accounted for during the transition cycles.

RESPONSE

PBAPS plans to fully implement EPU power within 90 days after completing the R20 outage at each unit. Consequently C21 is a full EPU cycle, and there are no EPU transition cycles. Similarly, the PBAPS C21 core is also planned to be comprised of only GNF2 fuel; thus, there are no fuel-type transition considerations. The [[

]] in accordance with GESTAR-II (Reference 5).

For the reference equilibrium EPU core, PUSAR Section 2.8.2.3 (Reference 1) evaluates the core's reactivity characteristics in [[

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Table 7-3 of the response to SNBP RAI-7 provides the [[

]] beyond the limit prescribed by the plant's Technical Specifications.

As described by the IMLTR Revision 0 SER Section 3.2.8 (Reference 4), “there is essentially no change in the cold critical prediction based on EPU core designs." The eigenvalue bias and uncertainty are addressed in the IMLTR Section 2.3, IMLTR Supplement 3 SER Sections 3.2.1.1, 3.2.1.2, and 3.2.2.7, and IMLTR Revision 4 Appendix C (see RAIs 2.0 - 2.3, and RAI 25 from GEH letter MFN 05-029). These evaluations conclude that the utilized eigenvalue biases and uncertainties are appropriate for GNF2 fuel at EPU conditions.

SNPB RAI-7

Provide a summary of fuel cycle calculations, for a representative equilibrium core design, that demonstrates the feasibility of EPU RTP operation while maintaining fuel design limits.

RESPONSE

For the EPU representative equilibrium core, the specific analyses required to demonstrate conformance to the fuel's thermal limits are documented within PUSAR Sections 2.8.1 through 2.8.5 (Reference 1). The analyses in these PUSAR sections conform with ELTR1 Sections 5.3 and 5.7, Appendix D, and Appendix E (Reference 3). Supplemental information on reactor core and fuel performance may also be found in CLTR Sections 2.0 - 2.4, 4.3, and 9.1 (Reference 2). These evaluations demonstrate the compliance of the reference equilibrium core with the SAFDLs. For future cycles, GESTAR-II (Reference 5), Sections S.1 through S.5 detail the cycle-specific reload analyses.

Key representative equilibrium core inputs, and key outputs demonstrating conformance to fuel design limits, are summarized below.

Table 7-1
Key Inputs for the PBAPS EPU Representative Equilibrium Core

Parameter	PBAPS EPU Value
Reactor Power Level	3951 megawatts thermal (MWt)
Total Cycle Energy	2,766,787 megawatt-days (MWd)
Minimum Core Flow	99.0% of rated core flow (RCF)
Maximum Core Flow	110% RCF
Coastdown Length	103,036 MWd

Reload bundle design and reload batch size data to support the above inputs for the PBAPS EPU representative equilibrium core design are presented in Table 7-2.

Table 7-2
Reload Bundle Designs for
PBAPS EPU Representative Equilibrium Core

Bundle	Batch Size (each cycle)	Bundle Identifier	Bundle Average Enrichment w% U235	Bundle Weight kg U kg UO2	Maximum Lattice Enrichment w% U235	Maximum Pool Storage k-infinity / Exposure
1	[[					
2						
3						]]

Results of the analysis of the PBAPS EPU representative equilibrium core are presented in Tables 7-3 through 7-6. All design limits are met. Therefore, the feasibility of the PBAPS EPU representative equilibrium core is confirmed.

Table 7-3 – Key Results for PBAPS EPU Representative Equilibrium Core

Parameter	Unit	PBAPS EPU Value	Design Limit	Result Description
MFLCPR[1] Thermal Margin	N/A	[[		
MFLPD[2] Thermal Margin	N/A			
MAPRAT[3] Thermal Margin	N/A			
Hot Excess Reactivity Margin[4]	%			
Cold Shutdown Reactivity Margin[5]	%			
Standby Liquid Control (SLCS) Shutdown Reactivity Margin[6]	%			
Maximum Lattice Kinfinity / Fuel Storage Reactivity	K_∞			
Residence Time	years			
Peak Bundle Average Discharge Exposure	GWd/MT			
Peak Pellet Exposure	GWd/MT			
Peak Nodal Exposure Ratio	N/A			]]

Notes

7. MFLCPR: Maximum Fraction of Limiting Critical Power Ratio (MCPR to limit)
8. MFLPD: Maximum Fraction of Limiting Power Density to Limit Ratio (MLHGR to limit)
9. MAPRAT: Ratio Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) to limit
10. See Table 7-4 for detailed results
11. See Table 7-5 for detailed results
12. See Table 7-6 for detailed results

Table 7-4 Hot Excess Reactivity Margins

CYCLE EXPOSURE (MWD/ST)	CRITICAL EIGENVALUE (HOT)	HOT All Rod Out (ARO) PANACEA k-EFFECTIVE (at 100% core flow)	HOT EXCESS REACTIVITY (at 100% core flow)
0	[[		
200			
1000			
2000			
2700			
3000			
4000			
5000			
5400			
6000			
7000			
8000			
8100			
9000			
10000			
10800			
11000			
12000			
13000			
13500			
14000			
15000			
15000			
15250			
15250			
16000			
16000			
16153			
16153			
16466			
17013			
17671			]]

Table 7-5 Cold Strongest Rod Out (SRO) Shutdown Margin

CYCLE EXPOSURE (MWD/ST)	COLD CRITICAL EIGENVALUE (LOCAL)	COLD SRO k-EFFECTIVE (PANACEA)	ROD WORTH (Δk)	LOCATION (SITE)	COLD SRO SHUTDOWN MARGIN (Δk)
0	[[				
200					
1000					
2000					
2700					
3000					
4000					
5000					
5400					
6000					
7000					
8000					
8100					
9000					
10000					
10800					
11000					
12000					
13000					
13500					
14000					
15000					
15000					
15250					
15250					
16000					
16000					
16153					
16153					
16466					
17013					
17671					}]]

Table 7-6 Cold All Rods Out (ARO) SLCS Shutdown Margin

CYCLE EXPOSURE (MWD/ST)	SLCS COLD ARO 726PPM @ 160ºC PANACEA k-EFFECTIVE	COLD CRITICAL EIGENVALUE (DISTRIBUTED)	SLCS COLD ARO 726PPM @ 160ºC SHUTDOWN MARGIN (Δk)
0	[[		
200			
1000			
2000			
2700			
3000			
4000			
5000			
5400			
6000			
7000			
8000			
8100			
9000			
10000			
10800			
11000			
12000			
13000			
13500			
14000			
15000			
15000			
15250			
15250			
16000			
16000			
16153			
16153			
16466			
17013			]]

SNPB RAI-8

Provide a summary of analyses performed to determine the thermal limits listed below. The summary should include the methodology, computer codes used, and the results obtained from the analyses. Also, please provide the impact of increased bundle power on the following operating parameters.

a. Safety Limit MCPR

b. Operating Limit MCPR

c. APLHGR Limit

d Linear Heat Generation Rate (LHGR)

RESPONSE

A discussion of the EPU impact on each of the requested parameters is provided in PUSAR Sections 2.8.2.2.1 through 2.8.2.2.4 (Reference 1), and in the ECCS performance evaluation described in PUSAR Section 2.8.5.6.2.5. These PUSAR sections provide references to the methodology.

A summary of each PUSAR section is presented below:

e. The impact of EPU upon the PBAPS SLMCPR is described in PUSAR Section 2.8.2.2.1 to be an expected increase of less than 0.02 caused by flattening of the radial power distribution.

f. The impact of EPU upon the PBAPS OLMCPR is described in PUSAR Section 2.8.2.2.2 to be an expected increase of less than 0.03 attributable to changes in void and scram reactivity response caused by flattening of the radial power distribution.

g. The impact of EPU upon the PBAPS APLHGR limit is described in PUSAR Section 2.8.2.2.3 and there is no effect. Conformance with the APLHGR limit is demonstrated in PUSAR Section 2.8.5.6.2.

h. LHGR Operating Limits are developed generically for each fuel product line (e.g., GNF2). They are determined from thermal-mechanical considerations and independent of any particular core design. The LHGR Operating Limit is described in PUSAR Section 2.8.2.2.4 and is unaffected by EPU.

The computer codes used in these evaluations are those listed in PUSAR Table 1-1.

The PUSAR attributes the SLMCPR and OLMCPR impacts to changes in the radial power distribution, and EPU flattens the radial power distribution by increasing the number of bundles operating at the higher average power.

SNPB RAI-9

Please describe how the required hot excess reactivity and shutdown margin are maintained in the uprated PBAPS unit cores.

RESPONSE

For the EPU representative equilibrium core, PUSAR Section 2.8.2.3 (Reference 1) evaluates the core's reactivity characteristics in conformance with ELTR1 Section 5.7.1 (Reference 3). Reactivity margins are maintained during the standard reload process (GESTAR-II, Reference 5, see Section 3.2.4.1) through the core and bundle design optimization.

The response to SNPB RAI-6 provides additional information regarding the treatment of bias and uncertainty in the reactivity evaluations for EPU.

The PBAPS EPU representative equilibrium core reactivity margin results are provided in the response to SNPB RAI-7.

SNPB RAI-10

GDC 10 requires that the reactor core and associated coolant, control and protection systems to be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs. A critical heat flux correlation specific to a type of fuel is developed, for use in the core design and safety analyses, to accurately predict the expected critical power performance. The PUSAR for PBAPS has not included a description of how SAFDLs are maintained during normal operations and during any AOOs. Please provide responses to the following requests:

a. Provide details of the specific GEXL correlation that will be used to determine the thermal margin for the uprated operating cycles for the PBAPS unit cores. Your response should include how the correlation is used to determine the change in critical power ratio (CPR) during postulated transients and in the determination of an acceptable MCPR limit.

b. Please provide a discussion of the impact of increased bundle power due to EPU on the CPR performance and the R-factor.

RESPONSE

The data presented in PUSAR Section 2.8.5 (Reference 1) demonstrate that the reactor protection and safety systems ensure GNF2 thermal limits are not exceeded as a result of PBAPS EPU AOOs for the representative equilibrium core. The standard reload process ensures that the thermal limits are not exceeded for any cycle.

The GNF2 GEXL correlation currently used by PBAPS is GEXL17 (Reference 7), and the GEXL17 correlation applies to both non-uprated and uprated conditions. Correlation use is described within the appropriate code topical reports presented in PUSAR Table 1-1.

To achieve EPU power levels, the EPU cores contain more bundles operating at a higher average power. This acts to flatten the radial power shape which alters the void and scram reactivity response which subsequently acts to alter the CPR performance. This effect is offset by the bundle and core design optimization process with the R-factor component being improved through bundle design optimization and the CPR performance is improved through core loading optimization to reduce the peak bundle powers.

SNPB RAI-11

Section 2.8.2.4.4 of the PUSAR provides the licensee's response to Limitation and Condition 9.24 of GEH Licensing Topical Report (LTR) NEDC-33173-P-A, "Applicability of GE Methods to Expanded Operating Domains," for EPU applications. The licensee has provided Figures 2.8-1 through 2.8-6 in which the PBAPS data are plotted with the available EPU experience base as required by the Limitation and Condition 9.24. However, there is no qualitative description of how the PBAPS data at various cycle exposure statepoints to provide insight in to the core conditions of the plant-specific application against the EPU experience base. Therefore, please provide how the parameters for PBAPS behave with respect to the EPU experience base as indicated in these plots.

In addition, the licensee has provided Figures 2.8-7 through 2.8-18 showing bundle power, bundle operating MCPR, and LHGR for the beginning of cycle (BOC), middle of cycle (MOC) and end of cycle (EOC). The purpose of this limitation/condition is for evaluation of minimum margins to specific limits at various applicable exposures. As such, please discuss the availability of margins for the specified parameters in the figures mentioned above.

RESPONSE

PUSAR Section 2.8 (Reference 1), Table 2.8-1, and Figures 2.8-1 through 2.8-6 present data required by the IMLTR Limitation and Condition 9.24 (Reference 4). The table and figures provide the prediction of key parameters for cycle exposures for operation at EPU plotted against the IMLTR experience base. This data shows no unusual deviations or unexpected results from the EPU database presented within IMLTR SER Section 2. Additional information and observations regarding that data, as well as that presented in Tables 2.8-7 through 2.8-18, are provided below.

PUSAR Figure 2.8-1 shows maximum bundle power as a function of exposure. The PBAPS EPU bundles reach slightly higher bundle powers, ranging from approximately 6.9 to 7.6 MW, compared to the reference experience base, but are largely consistent with the highest bundle powers for the reference plants. The plot shows that the maximum bundle power is sensitive to control blade density as evidenced by abrupt power changes associated with sequence exchanges. The End of Cycle (EOC) coastdown is visible with a nearly linear decrease in maximum bundle power.

PUSAR Figure 2.8-2 shows requested flow for peak bundle. As with PUSAR Figure 2.8-1, the PBAPS EPU flows are near the high end of the IMLTR experience base, ranging from approximately 11×10^4 to 12.5×10^4 lbm/hr. The flow is relatively constant throughout the cycle, which is a reflection of the narrow flow window associated with EPU power. The EOC increased core flow is clearly visible.

PUSAR Figure 2.8-3 shows exit void fraction for peak power bundle. The PBAPS EPU void fraction is consistent with the IMLTR experience base, and it varies about 0.85. Because the void fraction is plotted for the peak power bundle, the void fraction variations are quite similar to the power variations shown in PUSAR Figure 2.8-1. The drop in void fraction, created by power coastdown at EOC, is visible.

PUSAR Figure 2.8-4 shows the maximum channel exit void fraction. The PBAPS EPU void fraction is consistent with the IMLTR experience base, and it ranges from approximately 0.82 to 0.86. As expected, the peak power bundle typically generates the maximum exit void fraction and PUSAR Figure 2.8-4 is nearly identical to PUSAR Figure 2.8-3.

PUSAR Figure 2.8-5 shows the core average exit void fraction. The PBAPS EPU data falls squarely in the middle of the IMLTR experience base. As expected, the average void fraction values are less than the PUSAR Figure 2.8-3 maximum values, and the average void fractions are less responsive to reactivity control than the peak power bundle. The average void fraction is more responsive to the EOC power coastdown and shows a large, nearly linear, decrease at EOC.

PUSAR Figure 2.8-6 shows the peak LHGR. The PBAPS EPU LHGRs are consistent with the IMLTR experience base. The peak LHGR shows a shallow decrease with increasing exposure, and this decrease is less than that for a given individual rod because the peak LHGR of all rods is plotted. All LHGR values are below the PLHGR limits for GNF2.

PUSAR Table 2.8-1 shows peak nodal exposure. The PBAPS EPU value falls within the IMLTR experience base. While the nodal exposure is near the high end of the database, the nodal exposure remains below the GNF2 limit.

PUSAR Figures 2.8-7 through 2.8-18 show the quarter-core maps (the representative equilibrium core design is quarter-core symmetric) with bundle power, bundle operating LHGR and CPR for BOC, MOC, and EOC. Since the minimum margins to specific limits occur at exposures other than the traditional BOC, MOC, and EOC, figures are also supplied for the limiting exposures.

PUSAR Figures 2.8-7 through 2.8-9 and 2.8-16 present the dimensionless bundle power for which there is no specific limit. Because there is no bundle power limit, a margin discussion is not applicable. However, the bundle power is effectively limited by CPR and LHGR, and margin descriptions are provided herein for those parameters. The bundle powers shown by these figures are similar to bundle powers seen at current operation, and there are no unexpected changes for EPU.

PUSAR Figures 2.8-10 through 2.8-12 and 2.8-17 present the bundle operating LHGRs, and all bundles are below the GNF2 exposure-dependent LHGR limit. Figure 2.8-17 shows a peak LHGR of 10.73 kW/ft. This peak occurs in the exposure region where the LHGR limit is linearly decreasing and there is approximately [[ ]] to the LHGR limit (see Table 7-3 in the response to SNPB RAI-7). For EPU, there are no unexpected changes in LHGR, and any change in margin is managed by [[

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PUSAR Figures 2.8-13 through 2.8-15 and 2.8-18 present the bundle operating MCPRs and all exceed the assumed EPU SLMCPR (PUSAR Table 2.8-2) plus the maximum ΔCPR from the analyzed AOOs (PUSAR Table 2.8-12). Also, the MCPRs all exceed the assumed OLMCPR from the stability setpoint demonstration calculations (PUSAR Table 2.8-2). The EPU values show approximately [[ ]] to the assumed OLMCPR (see Table 7-3 in the response to SNPB RAI-7). For EPU, there are no unexpected changes in MCPR, and any change in margin is managed by [[

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SNPB RAI-12

Depending on the response to SNPB RAI-1 for the types of fuel (GE14 and/or GNF2), will any of the PBAPS unit cores qualify as a mixed core? If any of the cores is a mixed core, provide a detailed description as to how Limitation and Conditions 9.21 and 9.22 of NEDC-33173P-A are satisfied.

RESPONSE

The response to SNPB RAI-1 clarifies that the initial PBAPS EPU cores (U2 C21 and U3 C21) will not be mixed cores. PUSAR Sections 2.8.2.4.6 and 2.8.2.4.7 (Reference 1), affirm that the IMLTR Limitation and Conditions 9.21 and 9.22 (Reference 4) are not applicable to the PBAPS EPU.

SNPB RAI-13

In a draft RAI on May 14, 2013, the NRC staff indicated that it plans to run confirmatory calculations of the GNF2 fuel rod design using the FRAPCON-3.4 computer code to support the PBAPS EPU review. In this RAI, the staff requested that the licensee provide the input parameters needed to perform the calculations. In a conference call on May 23, 2013, the licensee stated that this issue relates to the GNF2 fuel design, which has been previously reviewed generically by the NRC staff (i.e., issue is not specific to the PBAPS EPU review). In an e-mail on May 29, 2013, the licensee referenced the NRC staff's safety evaluation (SE) for Amendment 32 to Topical Report NEDE-24011-P, "General Electric Standard Application for Reactor Fuel (GESTAR II)" dated July 30, 2009 (ADAMS Accession No. ML091680754). Specifically, the licensee's e-mail stated that the NRC staff had confirmed the GNF2 fuel rod designs using the FRAPCON computer code as discussed in the staff's SE for Amendment 32 to GESTAR II. As such, the licensee questioned the need for the staff to perform confirmatory calculations using the FRAPCON code to support the PBAPS EPU.

The NRC staff has reviewed this issue further based on the above interactions with the licensee. The NRC staff has determined that, provided that PBAPS maintains the same thermal-mechanical operating limit (TMOL) and thermal overpower (TOP)/mechanical overpower (MOP) limits, that were part of the GNF2/PRIME implementation, then no further FRAPCON confirmatory calculations by the staff are necessary. Please provide detailed justification for not providing the FRAPCON input parameters by explaining that plant operation, at EPU conditions, will maintain the same TMOL and TOP/MOP limits that were part of the original GNF2/PRIME implementation.

RESPONSE

Revision 3 to the GNF2 GESTAR II Compliance Report (NEDC-33270P) represents the original application of the approved PRIME thermal-mechanical (T-M) methodology to the GNF2 fuel T-M design basis and includes the documentation of the original PRIME-based thermal-mechanical operating limits (TMOL), including LHGR and TOP/MOP limits. As indicated in the NRC SE to Amendment 33 of GESTAR (Reference 5), the NRC staff performed confirmatory calculations of GNF2 with FRAPCON using these PRIME-based limits and determined that the GNF2 fuel rod design satisfies all T-M related licensing criteria. The GNF2 PRIME-based TMOL and TOP/MOP limits originally documented in Revision 3 of NEDC-33270P have not changed and remain the applicable PRIME-based limits for GNF2 fuel bundles in US BWR/3-6 plants, including PBAPS, as documented in the current revision of NEDC-33270P (Reference 8)."

Therefore, it is confirmed that the TMOL and TOP/MOP limits that were part of the original GNF2/PRIME implementation will be maintained for PBAPS at EPU conditions.

REFERENCES

1. Letter from K. F. Borton (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "License Amendment Request - Extended Power Uprate," dated September 28, 2012 (ML122860201), Attachments 4 and 6 (PUSAR).

2. GE Nuclear Energy Topical Report, "Constant Pressure Power Uprate," NEDC-33004P-A, Revision 4, July 2003; and NEDO-33004, July 2003. (CLTR)

3. GE Nuclear Energy Topical Report, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," NEDC-32424P-A, February 1999; and NEDO-32424, April 1995. (ELTR1)

4. GE Nuclear Energy Topical Report, "Applicability of GE Methods to Expanded Operating Domains," NEDC-33173P-A, Revision 4, November 2012. (IMLTR) Note – this document includes Revision 4 text and the NRC Safety Evaluations for Rev 0 and Rev 2 and Supplements 3 and 4.

5. Global Nuclear Fuels Topical Report, "General Electric Standard Application for Reactor Fuel," NEDE-24011P-A and NEDE-24011P-A-US, Revision 19, Amendment 35, May 2012 (GESTAR-II). This is current approved version; a Revision Status Sheet in the document provides cross-reference information to any specific revisions, amendments or safety evaluations cited in the responses.

6. GE Nuclear Energy Topical Report, "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate," NEDC-32523P-A, February 2000; NEDC-32523P-A, Supplement 1 Volume I, February 1999; and Supplement 1 Volume II, April 1999. (ELTR2)

7. Global Nuclear Fuel Topical Report, "GEXL17 Correlation for GNF2 Fuel," NEDC-33292P, Revision 3, June 2009.

8. Global Nuclear Fuel Topical Report, “GNF2 Advantage Generic Compliance with NEDE-24011P-A (GESTAR II),” NEDC-33270P, Revision 5, May 2013.

9. Letter from T. B. Blount (NRC) to A.A. Lingenfelter (GNF), “Final Safety Evaluation for Amendment 33 to Global Nuclear Fuel Topical Report NEDE-24011P, “General Electric Standard Application for Reactor Fuel (GESTAR II)”” dated August 30, 2010.

10. Global Nuclear Fuel Topical Report, “The PRIME Model for Analysis of Fuel Rod Thermal-Mechanical Performance Part 3 – Application Methodology,” NEDC-33258P-A, Revision 1, September 2010.

ACRONYM LIST

ACRONYM	DEFINITION
AOO	Anticipated operating occurrence
APLHGR	Average planar linear hear generation rate
ATWS	Anticipated transient without scram
BOC	Beginning of cycle
BWR	Boiling water reactor
CLTR	Constant Pressure Power Uprate topical report – Reference 2
COLR	Core operating limits report
CPPU	Constant pressure power uprate
ΔCPR	Delta CPR or Change in Critical Power Ratio
ECCS	Emergency core cooling system
EGC	Exelon Generation Company
ELTR1	Extended power uprate topical report – Reference 3
ELTR2	Extended power uprate topical report – Reference 6
EOC	End of cycle
EPU	Extended power uprate
GESTAR-II	Core design topical report – Reference 5
GNF2	A fuel type
IMLTR	GEH Interim Methods LTR – Reference 4
LAR	License amendment request
LHGR	Linear heat generation rate
LOCA	Loss of coolant accident
LTR	Licensing Topical Report
MAPRAT	Ratio maximum average planar linear heat generation rate to limit
MCPR	Minimum critical power ratio
MELLLA+	Maximum extended load line limits analysis-plus; potential future operating domain
MFLCPR	Ratio maximum fraction of limiting critical power to limit)
MFLPD	Ratio maximum fraction of limiting power density to limit

ACRONYM	DEFINITION
MOC	**Middle of cycle**
MOP	**Mechanical overpower**
OLMCPR	**Operating limit minimum critical power ratio**
PBAPS	**Peach Bottom Atomic Power Station**
PUSAR	**Power uprate safety analysis report – Reference 1**
RAI	**Request for additional information (from NRC)**
RCF	**Rated core flow**
RCIC	**Reactor core isolation cooling system**
RHR	**Residual heat removal system**
SAFDL	**Specified acceptable fuel design limit**
SDM	**Shutdown margin**
SER	**Safety evaluation report (issued by NRC)**
SLCS	**Standby liquid control system**
SLMCPR	**Safety limit minimum critical power ratio**
SRLR	**Supplemental reload licensing report**
SRP	**Standard review plan**
TMOL	**Thermal-mechanical overpower limits**
TOP	**Thermal overpower**