Exelon Generation.

PROPRIETARY INFORMATION – WITHHOLD UNDER 10 CFR 2.390

10 CFR 50.90
10 CFR 2.390

May 7, 2013

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

Peach Bottom Atomic Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-44 and DPR-56
NRC Docket Nos. 50-277 and 50-278

Subject: Extended Power Uprate, Supplement 2 - Response to Request for Additional Information

Reference:
1. Exelon letter to the NRC, "License Amendment Request - Extended Power Uprate," dated September 28, 2012 (ADAMS Accession No. ML122860201)
2. NRC letter to Exelon, "Request for Additional Information Regarding License Amendment Request for Extended Power Uprate (TAC Nos. ME9631 and ME9632," dated March 28, 2013

In accordance with 10 CFR 50.90, Exelon Generation Company, LLC (EGC) requested amendments to Facility Operating License Nos. DPR-44 and DPR-56 for Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3, respectively (Reference 1). Specifically, the proposed changes revised the Renewed Operating Licenses to implement an increase in rated thermal power from 3514 megawatts thermal (MWt) to 3951 MWt. During their technical review of the application, the NRC Staff identified the need for additional information. Reference 2 provided the NRC Request for Additional Information.

This letter addresses the U. S. Nuclear Regulatory Commission staff request to provide information demonstrating that the effects of thermal conductivity degradation have been considered for the extended power uprate.

ADD1
NRR

Attachment 1 transmitted contains Proprietary Information. When separated from Attachment 1, this document is decontrolled.

GE Hitachi Nuclear Energy America (GEH) considers portions of the information provided in the attached response to be proprietary and, therefore, exempt from public disclosure pursuant to 10 CFR 2.390. The proprietary information in Attachment 1 is identified; this information has been redacted from Attachment 2. In accordance with 10 CFR 2.390, EGC requests Attachment 1 be withheld from public disclosure. An affidavit supporting this request for withholding is included as Attachment 3. A non-proprietary version of this information is provided in Attachment 2.

EGC has reviewed the information supporting a finding of no significant hazards consideration and the environmental consideration provided to the U. S. Nuclear Regulatory Commission in Reference 1. The supplemental information and corrections provided in this submittal do not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. In addition, the additional information and corrections provided in this submittal do not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.
In accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b), EGC is notifying the Commonwealth of Pennsylvania and the State of Maryland of this application by transmitting a copy of this letter along with the non-proprietary attachments to the designated State Officials.

There are no regulatory commitments contained in this letter.

Should you have any questions concerning this letter, please contact Mr. David Neff at (610) 765-5631.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 7th day of May, 2013.

Respectfully,

Kevin F. Borton
Manager, Licensing – Power Uprate
Exelon Generation Company, LLC

Attachments:
1. Response to Request for Additional Information – Proprietary
2. Response to Request for Additional Information – Non-Proprietary
3. Affidavit in Support of Request to Withhold Information

cc:	USNRC Region I, Regional Administrator	w/attachments
	USNRC Senior Resident Inspector, PBAPS	w/attachments
	USNRC Project Manager, PBAPS	w/attachments
	R. R. Janati, Commonwealth of Pennsylvania	w/o proprietary attachments
	S. T. Gray, State of Maryland	w/o proprietary attachments

Attachment 3

Peach Bottom Atomic Power Station Units 2 and 3

NRC Docket Nos. 50-277 and 50-278

<u>Affidavit in Support of Request to Withhold Information</u>

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Linda C. Dolan, state as follows:

(1) I am the Manager, Regulatory Compliance of GE-Hitachi Nuclear Energy Americas LLC (GEH), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Attachment 1 of GEH letter, GEH-PBAPS-EPU-408, "GEH Response to NRC Reactor System Branch RAI-1," dated April 26, 2013. The GEH proprietary information in Attachment 1, which is entitled "GEH Response to SRXB RAI-1 GEH Proprietary Information-Class III (Confidential)" is identified by a dark red dotted underline inside double square brackets. [[This sentence is an example.{3}]]. Figures containing GEH proprietary information are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit that provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the *Freedom of Information Act* (FOIA), 5 U.S.C. Sec. 552(b)(4), and the *Trade Secrets Act*, 18 U.S.C. Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F.2.d 871 (D.C. Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F.2.d 1280 (D.C. Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over GEH or other companies.

b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, that may include potential products of GEH.

d. Information that discloses trade secret or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to the NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited to a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary or confidentiality agreements.

(8) The information identified in paragraph (2) above is classified as proprietary because it contains the results of an analysis performed by GEH to support the Peach Bottom Atomic Power Station Extended Power Uprate (EPU) license application. This analysis was made using the GEH EPU methodology, which is a proprietary method created by GEH for this purpose. Development of the EPU methodology and the supporting analysis techniques and information, and their application to the design, modification, and processes were achieved at a significant cost to GEH.

The development of the evaluation methodology along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply

the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 26th day of April, 2013.

Linda C. Dolan

Linda C. Dolan
Manager, Regulatory Compliance
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Attachment 2

Peach Bottom Atomic Power Station Units 2 and 3

NRC Docket Nos. 50-277 and 50-278

Response to Request for Additional Information – Non-Proprietary

Response to Request for Additional Information

Reactor Systems Branch

By letter dated September 28, 2012, Exelon Generation Company, LLC (Exelon) 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 Reactor Systems Branch staff has reviewed the information supporting the proposed amendment and by letter dated March 28, 2013 has requested information to clarify the submittal. The response to that request is provided below.

SRXB RAI-1:

Background

On December 13, 2011, the NRC staff issued Information Notice (IN) 2011-21, "Realistic Emergency Core Cooling System Evaluation Model Effects Resulting from Nuclear Fuel Thermal Conductivity Degradation" (ADAMS Accession No. ML113430785). This IN addressed the potential for a phenomenon called thermal conductivity degradation (TCD) to cause errors (specifically higher peak cladding temperature (PCT)) in realistic emergency core cooling system (ECCS) evaluation models. IN 2009-23, "Nuclear Fuel Thermal Conductivity Degradation," dated October 9, 2009 (ADAMS Accession No. ML091550527), stated that pre-1999 methods may misrepresent fuel thermal conductivity and that calculated margins to specified acceptable fuel design limits and other limits may be less conservative than previously understood. On October 26, 2012, the NRC staff issued Supplement 1 to IN 2009-23 (ADAMS Accession No. ML121730336). This IN stated that safety analyses performed for reactors using methods that do not model TCD as a function of burnup may be less conservative than previously understood.

In a letter dated July 19, 2009 (ADAMS Accession No. ML083530224), the NRC staff issued a final safety evaluation (SE) for GE-Hitachi Nuclear Energy Americas LLC (GEH) licensing topical report (LTR) NEDC-33173P, "Applicability of General Electric Methods to Expanded Operating Domains." Section 9.0, "Limitations and Conditions," item 12, of the NRC staff SE (ADAMS Accession No. ML091170541), stated that:

> *In MFN 06-481, GE committed to submit plenum fission gas and fuel exposure gamma scans as part of the revision to the T-M [thermal mechanical] licensing process. The conclusions of the plenum fission gas and fuel exposure gamma scans of GE 10x10 fuel designs as operated will be submitted for NRC staff review and approval. This revision will be accomplished through Amendment to GESTAR II or in a T-M licensing LTR. PRIME (a newly developed T-M code) has been submitted to the NRC staff for review (Reference 58). Once the PRIME LTR and its application are approved, future license applications for EPU and*

> *MELLLA+ referencing LTR NEDC-33173P must utilize the PRIME T-M methods.*

In a letter dated January 22, 2010 (ADAMS Accession No. ML100190258), the NRC staff approved three topical reports associated with the PRIME model for analysis of fuel rod thermal mechanical performance.

In a letter to GEH dated March 23, 2012 (ADAMS Accession No. ML120680599), the NRC staff raised concerns regarding the use of historical fuel thermal conductivity models in the safety analyses of operating reactor plants. The letter cited concerns regarding TCD as stated in IN 2011-21. In addition, the letter requested that GEH inform all licensees using GEH evaluation models of any analytical changes that could affect the licensees' compliance with 10 CFR 50.46. GEH responded to the NRC's letter in a letter dated May 8, 2012 (ADAMS Accession No. ML12129A437). The GEH letter discussed the transition from the GSTRM model to the PRIME model to address the TCD issue.

Section 2.8.5.6.2.5, "Emergency Core Cooling System Performance," of Attachment 4 to the PBAPS EPU application dated September 28, 2012 (ADAMS Accession No. ML122860201), stated, in part, that:

> *The EPU Licensing Basis PCT [peak cladding temperature] for GNF2 fuel is less than 1925°F, which represents an increase from the CLTP [current licensed thermal power] Licensing Basis PCT of less than 1870°F evaluated at CLTP power and rated core flow. The EPU Licensing Basis PCT incorporates the effects of all identified Evaluation Model changes and errors as noted by the 10 CFR 50.46 reporting process through notification letter 2011-03.*

Section 2.8.5.6.2.5.2 and Table 1-1 in Attachment 4 to the application, indicate that the ECCS loss-of-coolant accident (LOCA) analysis was performed using the SAFER/GESTR-LOCA evaluation model. The SAFER/GESTR-LOCA model uses the GESTR-LOCA model for fuel rod thermal-mechanical performance and for the fuel temperature calculation. The GESTR-LOCA component of the SAFER/GESTR-LOCA evaluation model is based on the GSTRM fuel performance model, which does not account for the burn up-dependent effects of nuclear fuel TCD.

Based on recent discussions with the licensee, the NRC staff understands that, in November 2012, GEH notified Exelon of a change to the GEH ECCS-LOCA methodology for PBAPS. Specifically, to address the TCD issue with respect to ECCS evaluation, GEH replaced the GESTR-LOCA model with the PRIME model. The NRC staff also understands that GEH's letter addressed the current licensing basis, as well as the proposed EPU conditions.

Exelon stated that, consistent with 10 CFR 50.46, since the change in PCT was less than 50 degrees F, the information would be submitted to the NRC with the annual 10 CFR 50.46 report in August 2013.

As noted above, the current EPU application is based on evaluation model changes and errors, as noted by the 10 CFR 50.46 reporting process, through a 2011 notification letter. The current EPU application and the supplement dated February 15, 2013, do not address the November 2012 notification letter from GEH to Exelon.

Issue

The licensee's safety analyses (including ECCS LOCA), supporting the proposed EPU, were performed using GSTRM based safety analysis methods that do not properly account for the effects of TCD. Methods that do not account for TCD may under predict the fuel's calculated PCT.

Request

In order to properly evaluate the safety analyses, including ECCS-LOCA performance under EPU conditions, the NRC staff requests the licensee to provide information based on revised safety analyses, including ECCS-LOCA, that account for the effects of TCD. TCD is acceptably considered, for example, in the PRIME evaluation model.

This information should be sufficiently complete to allow the staff to determine whether ECCS cooling performance was calculated consistent with the requirements in 10 CFR 50.46(a)(1)(i). Specifically, as stated in this regulation, "ECCS cooling performance must be calculated in accordance with an acceptable evaluation model and must be calculated for a number of postulated loss-of-coolant accidents of different sizes, location, and other properties sufficient to provide assurance that the most severe loss-of-coolant accidents are calculated."

Detailed results should be provided for the most limiting case.

RESPONSE:

In order to demonstrate that thermal conductivity degradation (TCD) has been acceptably considered, Exelon Generation Company (EGC) has performed an analysis of the limiting ECCS-LOCA cases using the GEH PRIME model in conjunction with the NRC-approved SAFER evaluation model. As noted in the RAI, the NRC has found the treatment of TCD to be effectively and acceptably considered in the PRIME thermal-mechanical performance model. Results from the use of the PRIME model are presented below along with the results obtained using the GESTR-M model presented earlier in response to acceptance review questions (see Reference 5). As demonstrated in the discussion of ECCS-LOCA results below, the effect of PRIME implementation on the PBAPS EPU ECCS-LOCA analysis is either zero effect or an effect that is insignificant against safety analysis acceptance criteria. The resulting parameter values for the limiting 10 CFR 50.46 acceptance criteria for PBAPS actually decreased (improved) with the use of the PRIME model compared to the results obtained using the previous GESTR-M model.

In a clarification call regarding this question, the NRC also expressed interest in the potential impact of using the PRIME model in the analysis of other transients and events. EGC agreed to provide a discussion of why the use of the PRIME model would not be expected to impact the results of other safety analyses. The effect due to the implementation of PRIME as a replacement to GESTR-M on PBAPS EPU safety

analyses are presented below. The results of these evaluations on other transients and events indicate that the effect of PRIME implementation is either zero effect or an effect that is insignificant against safety analysis acceptance criteria.

Effect of PRIME Implementation on ECCS-LOCA Analysis (Reference 4, Section 2.8.5.6.2)

EGC has considered the effects of PRIME model input into the SAFER engineering computer program (ECCS-LOCA Evaluation Model) using two different approaches. Approach 1 is a detailed, PBAPS plant-specific evaluation performed for the limiting small-break and large break LOCA cases using PRIME. Approach 2 assesses the effect of the PRIME model input on the current and post-EPU licensing basis PCT consistent with the 10 CFR 50.46 notification process. The results of both approaches determined that the implementation of PRIME has zero effect on the PBAPS licensing basis PCT.

Approach 1 for ECCS-LOCA

As requested in this RAI, analyses of the limiting ECCS-LOCA cases (i.e., the limiting small break case and the limiting large break case) have been performed using the PRIME model input to the SAFER engineering computer program (Evaluation Model). The results of these re-analyses are presented in Table 1 below. Plots of these limiting small break and large break cases, including PRIME model data as input to the Evaluation Model calculation, are shown in Enclosures 1 and 2 to this RAI response. The figures in Enclosure 1 are comparable to Figures 6a through 6d of Reference 5. The figures in Enclosure 2 are comparable to Figures 5a through 5d of Reference 5.

The implementation of PRIME into the ECCS LOCA evaluation model only affects the model parameters for fuel rod thermal conductivity and gap conductance, which manifests itself in a slight increase in stored energy as an initial condition for the hypothesized event. The ECCS-LOCA evaluation model assumes the hot bundle is operating at the thermal limits (MCPR, MAPLHR, LHGR). GNF2 fuel PRIME-based thermal limits were used in analysis results reported in Reference 4 and 5 and are unchanged in the analysis results presented here.

Input assumptions that form the basis of conservatism for the analysis, or that serve to identify the bounding result as regards maximum PCT for compliance demonstration purpose, (bounding power shape, limiting condition for initial power and core flow across allowed operating domain, location of break, size of break and single active failure) do not change with the change in fuel rod model (PRIME versus GESTR-M) as initial condition. These effects on analysis results are related to system definition (vessel and associated piping geometry) and emergency response (ECCS setpoints, actuations and flow rates) and these exhibit no change due to the use of PRIME versus GESTR-M. Effects from these, such as break size and location, are driven by mass flow from the break, the depressurization of the vessel, the resulting water level based on achieved saturation condition, steam generation, density and internals geometry, along with time to reach setpoints and generate signals for safeguard system response. None of these are affected by the fuel rod conditions in the core. A resulting, bounding PCT case (for the same bounding power/flow condition, same limiting break size, etc.) would be consistently calculated, as reported in Reference 4. There is no further effect identified

that changes the analysis assuming a PRIME calculation of input to the model for the fuel rod. By extension, this observation also applies to the changes in initial condition which would be present in vessel and system configuration as a result of operation under licensed flexibility options. The effect of these, as well, does not change as a result of alternate fuel rod model.

A consistent implementation of PRIME from GESTR-M across the entire spectrum of breaks shown in Table 3.3.1 of Reference 5 would produce the same net impact for each break case. Because the information contained in Table 3.3.1 of Reference 5 clearly indicates the limiting PBAPS EPU large and small break cases, these same limiting cases were re-run with PRIME implemented into the Evaluation Model to show the impact of PRIME to address this RAI. Results from re-analysis of the limiting small break and DBA large break cases with the SAFER/PRIME model are shown below, as compared with the base cases of References 4 and 5:

Table 1: Comparison of PBAPS Limiting ECCS-LOCA Break Cases – GESTR-M versus PRIME

Small Break: [[ ]]	**SAFER/GESTR-M Base Case (EPU/Rated Flow)**	**SAFER/PRIME Case (EPU/Rated Flow)**
Limiting Break PCT	[[	
Core Wide Metal Water Reaction (%)		
Maximum Local Oxidation (%)		]]

Large Break: [[ ]]	**SAFER/GESTR-M Base Case (EPU/Rated Flow)**	**SAFER/PRIME Sensitivity Case (EPU/Rated Flow)**
Limiting Break PCT	[[	
Core Wide Metal Water Reaction (%)		
Maximum Local Oxidation (%)		]]

(1) Limiting case from References 4 and 5
(2) [[

]]

Plots of the PCT effect comparing the GESTR-M and PRIME fuel rod conditions are provided below in Figures 1a and 1b.

Figure 1a: DBA Break

[[

]]

Figure 1b: Small Break

[[

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The results of these two SAFER/PRIME cases indicate that related 10 CFR 50.46 acceptance criteria (core-wide metal water reaction, maximum local oxidation) are minimally impacted. Cladding oxidation and hydrogen generation are a function of the metallurgical characteristics of the cladding material, given the decay heat and oxidizing environment of the core. There would be minimal change in these factors, as indicated, given the similar heating/cooling response, regardless of modeling for the fuel rod initial condition. The increase in stored energy, acknowledged with PRIME, accounts for the small increase reported above, for the non-limiting large break case. The decay heat would not deviate as it started from the same base power level. Variation in oxidation could be slightly affected by the core cooling, but as shown in Table 1 above, that being very similar, there is no other factor which would appreciably change this result. Nothing regarding the fuel rod initial condition would affect the basis for conclusion of sustained long term core cooling requirement, nor of coolable geometry, which is affirmed with continued PCT criterion compliance.

Approach 2 for ECCS-LOCA

As noted in the RAI background information, GEH provided an evaluation model change notification to EGC (dated November 29, 2012). The November 29, 2012 notification letter identified the future use of PRIME as a change in the methodology used in the 10 CFR 50.46 analyses for PBAPS. This notification was submitted in conformance to the PRIME implementation plan outlined in Reference 2. This notification provided the

results of sensitivity studies to estimate the impact on the current and proposed EPU Licensing Basis PCT due to the use of the PRIME model. This notification letter for PBAPS indicated that the impact of the PRIME model on the Licensing Basis PCT would be 0°F.

In accordance with 10 CFR 50.46, licensees report the changes and errors to the NRC whenever the cumulative effect of outstanding changes results in a change in PCT of 50°F degrees or more, or annually.

The annual letter to the NRC regarding the PBAPS ECCS error notification impacts under the requirements of 10 CFR 50.46 is typically submitted in August.

Background on ECCS-LOCA Analyses Performed for PBAPS EPU and the Impact of PRIME

The ECCS-LOCA analyses performed in support of the EPU and reported in Reference 4 utilized the GESTR-M fuel model. Supporting the acceptance review of the PBAPS EPU license amendment request, a supplemental report (Reference 5) was prepared to present the background and additional details of the ECCS-LOCA analysis described in Section 2.8.5.6.2.5 of Reference 4. The PBAPS EPU analyses were performed in early 2010 using the NRC-approved methodologies. The NRC safety evaluation of Reference 7 noted:

> "The NRC staff assessed the impact on downstream calculations performed using the General Electric Stress and Thermal Analysis of Fuel Rods (GESTR)-Mechanical (GSTRM) fuel model and GSTRM gas gap conductivity files while the legacy safety analysis methods are migrated to the updated PRIME models. .... In this interim period, the thermal-mechanical operating limits (TMOL) will be determined using PRIME; however, transient safety analyses will be performed using the GSTRM inputs. The NRC staff notes that the GSTRM models do not account for the physical phenomenon of fuel pellet conductivity degradation with pellet exposure. The NRC staff refers to this process to be used during the period of time between PRIME approval and the eventual update of the legacy methods as the interim process.

As noted in the RAI background, in conformance to the PRIME implementation plan outlined in NEDO-33173, Supplement 4-A (Reference 2), an evaluation model change notification (dated 29 November 2012) was developed addressing the potential effect of PRIME on PCT for the ECCS-LOCA analysis. The process of NEDO-33173, Supplement 4, intended that as new ECCS-LOCA analyses were performed – whether by accumulation of model changes and errors per 10 CFR 50.46 standard or by plant and fuel changes occasioning need to demonstrate continuing ECCS-LOCA compliance – they would be performed with the PRIME model explicitly included, and supersede the November 29, 2012 GEH notification letter to EGC in accordance with 10 CFR 50.46. Specifically:

> "Supplement 4 further states that when PRIME is fully implemented in the SAFER code that the conservative estimate of the PCT adjustment

> will no longer be necessary as the calculations will be performed using the approved, updated models. The NRC staff agrees with this assessment."

Consistent with assessments of PRIME, and documented in Reference 3, the effect for ECCS-LOCA analysis is an increase in core stored energy as an initial condition. For small break, nucleate boiling which occurs in the early time periods following the accident, before vessel depressurization, has the effect of allowing removal of the (increased) core stored energy before the core is uncovered; subsequently, when pressure is relieved due to automatic depressurization system (ADS) action, the depth and duration of the uncovered core – defined by ECCS system performance – is essentially unchanged, resulting in a comparable PCT result between a GESTR-M-based and PRIME-based calculation. Key to understanding this result is the observation that TCD is an exposure dependent effect, and would not exhibit any influence at earlier exposures when the ECCS-LOCA analysis demonstrates maximum PCT result. This is consistent with Reference 6, which presents the evaluation observation that PCT results for the ECCS-LOCA analysis are greatest early in exposure time for the bundle – exposure "less than 20 or even 15 GWd/MTU." At higher exposures, a reduction in MAPLHGR will result in improved (reduced) PCT results, compensating in a measure during the exposure periods when TCD would become more prominent. The increase of core stored energy does show effect in the DBA large break case in terms of increased cladding heatup at early times of the accident (first peak), coincident with the more immediately uncovered core. This carries through consistently through the event, affecting the second peak, and is demonstrated in PBAPS results (See Table 1 above) as to net PCT change. Since the Licensing Basis PCT would rely on the more limiting small break PCT result, noting significant margin between that result and the non-bounding large break PCT, the effect of the PRIME code on the ECCS-LOCA analysis is reported as having 0°F effect as regards 10 CFR 50.46 compliance and reporting for the model change as compared with the EPU analysis reported in Reference 4.

Conclusion for ECCS-LOCA

The conclusions of PBAPS EPU acceptability to 10 CFR 50.46 remain identical to those stated in References 4 and 5. The results of the analysis presented here demonstrate that TCD (Reference 1) is acceptably accounted for in the PBAPS EPU analysis and that there is no impact on the Reference 4 and 5 reported EPU Licensing Basis PCT.

Effect of PRIME Implementation on Containment Response (Reference 4, Sections 2.6.1, 2.6.3 and 2.6.5) and Station Blackout (Reference 4, Section 2.3.5)

The safety analyses presented in these sections of Reference 4 are primarily concerned with acceptance criteria concerning the containment. The safety analyses codes used in these analyses, SHEX, LAMB, and M3CPT (see Table 1-1 of Reference 4) are not listed in NEDO 33173-Supplement 4-A (Reference 8) as requiring modification for PRIME implementation. The safety analyses codes used for these analyses use neither detailed reactor kinetics nor detailed fuel rod response characteristics. The results of these safety analyses in the short term are primarily driven by reactor and containment gross thermal-hydraulic initial conditions (core thermal power, reactor pressure, reactor

water level, core flow, core inlet subcooling, containment pressure, temperature and relative humidity). The results in the long-term are primarily driven by reactor decay heat, the suppression pool (torus) heat capacity, and the capacity of the containment heat removal system. Note that for the PBAPS Station Blackout analysis, reactor water level always remains well above top of active fuel so there is no fuel heat-up. Therefore, there is no TCD impact on these safety analyses.

<u>Effect of PRIME Implementation on Appendix R Fire Protection (Reference 4, Section 2.5.1.4)</u>

The PBAPS evaluation of Appendix R/fire protection determined the fuel, Reactor Pressure Vessel (RPV) and containment response to four fire safe shutdown methods. As stated in section 2.5.1.4.2 of Reference 4, shutdown methods "A", "B" and "D" have either the Reactor Core Isolation Cooling (RCIC) system or the High Pressure Coolant Injection (HPCI) system available to provide high pressure make-up to the RPV during the Appendix R event. Therefore, for shutdown methods "A", "B" and "D" reactor water level always remains above top of active fuel (TAF) and there is no fuel heat-up during these Appendix R fire-safe shutdown scenarios. This disposition concerning no fuel heat-up will not change due to the implementation of PRIME.

For shutdown method "C", no high pressure makeup is available and, as shown in Reference 4, Table 2.5-3 for the limiting shutdown method "C" evaluation, inventory loss through SRV cycling will eventually lead to RPV water level reaching TAF. When water level reaches TAF, the operator will start low pressure ECCS and manually depressurize the RPV. Low pressure ECCS injection will then restore RPV water level. The impact of PRIME implementation in the SAFER analysis of the fuel temperature response to Appendix R fire is analogous to the small break LOCA analysis presented earlier in this RAI response. Nucleate boiling which occurs in the early time periods following the event initiation, before vessel depressurization, has the effect of allowing removal of the (increased) core stored energy before the core is uncovered; subsequently, when pressure is relieved due to relief valve depressurization action, the depth and duration of the uncovered core – defined by ECCS system performance – is essentially unchanged, resulting in a comparable PCT result. Key to understanding this result is the observation that TCD is an exposure dependent effect, and would not exhibit any influence at earlier exposures when the SAFER evaluation analysis demonstrates greatest PCT result (as noted above, for LOCA, from Reference 6, exposure "less than 20 or even 15 GWd/MTU.") Therefore, the implementation of PRIME into the SAFER evaluation model for Appendix R fire has no effect on the results presented in Table 2.5-2 of Reference 4.

The Appendix R containment analyses results presented in Table 2.5-2 of Reference 4 are not affected by PRIME implementation. The safety analysis code used for the containment analysis portion of the Appendix R fire event, SHEX (see Table 1-1 of Reference 4), is not listed in NEDO-33173 Supplement 4-A (Reference 8) as requiring modification for PRIME implementation. The SHEX code uses neither detailed reactor kinetics nor detailed fuel rod response characteristics. These results in the long-term are primarily driven by reactor decay heat, the suppression pool (torus) heat capacity, and the capacity of the containment heat removal system. Therefore, there is no TCD impact on the containment response aspect of the PBAPS EPU Appendix R analysis.

The Appendix R maximum RPV pressure results presented in Table 2.5-2 of Reference 4 are determined by safety relief valve characteristics and decay heat, which are unaffected by PRIME implementation. The maximum operator response time for opening ADS valves, presented in Table 2.5-2 of Reference 4 is also unaffected by PRIME implementation. The timing is primarily affected by reactor decay heat and the rate of RPV inventory loss through SRV cycling during automatic RPV pressure control early in the event. Therefore, there is no TCD impact on the RPV pressure response aspect of the PBAPS EPU Appendix R analysis.

Effect of PRIME Implementation on Thermal Hydraulic Stability (Reference 4, Section 2.8.3.1)

Thermal-hydraulic stability analysis is cycle-specific and the analyses included in Reference 4 are for demonstration purpose only. There are no limits set or used from the stability demonstration analyses included in Reference 4. PRIME will be fully implemented in the upcoming PBAPS cycle-specific reload analyses.

The results for the stability safety analyses are based on ODYSY and TRACG calculations (See Table 1-1 of Reference 4).

[[

]] Impact as applicable to PBAPS EPU is detailed as follows: The PRIME method [[

]] A number of sensitivity studies have been performed to assess the impact on ODYSY decay ratio prediction. Based on these sensitivity studies, the change in the BSP region boundary at the Natural Circulation Line (NCL) point is [[

]] Although PBAPS at EPU was not specifically used in these analyses, the conclusions based on the ODYSY/PRIME sensitivity studies remain applicable to PBAPS.

Sensitivity studies documented in the response to RAI 39 of (Reference 7) have shown [[

]] The TRACG04 code is used in Stability Option III Long Term Solution (LTS) (Reference 10) to determine the DIVOM slope, which is a component to determine the stability based OLMCPRs. TRACG04 demonstration analyses that produced the results included in Reference 4 were generated using PRIME thermal conductivity model with GESTR-M gap conductance fuel files. TRACG04 sensitivity studies have shown that [[

]] Table 2 below provides the results for the quantification of the impact of such sensitivities on TRACG04 DIVOM analysis. Results in Table 2 show that [[

]] The DIVOM slope is used to determine the stability based OLMCPR. Based on this [[

]] for the demonstration analyses of PBAPS EPU by using TRACG04 PRIME thermal conductivity model with GESTR-M gap conductance fuel files. The results shown in Table 2 below are based on reference representative BWR plants used to assess impact on regional and core-wide DIVOM slopes. Although PBAPS was not specifically used in these analyses, the conclusions based on the results provided in Table 2 below are also applicable to PBAPS.

Table 2 - DIVOM Slope Results

Description	**TRACG04 PRIME Thermal Conductivity Model with GESTR-M Gap Conductance Fuel Files**	**TRACG04 PRIME Thermal Conductivity Model with PRIME Gap Conductance Fuel Files**	**Delta**
Core-wide Oscillations DIVOM Slope	[[		
Regional Oscillations DIVOM Slope			]]

<u>Effect of PRIME Implementation on Transient Analysis (Reference 4, Sections 2.8.5.1 through 2.8.5.5) and ATWS (Reference 4, Section 2.8.5.7)</u>

Tables 3 and 4 below contain representative comparisons of GESTR-M-based versus PRIME-based fast transient results where changes to fuel thermal conductivity affect results.

Given the margins in Reference 4 to design limits [[

]] seen in these comparisons, the Abnormal Operating Occurrence (AOO) and Anticipated Transient Without SCRAM (ATWS) results contained in Section 2.8.5 of Reference 4 are [[ ]].

Table 3 - Comparison of GESTR-M-based versus PRIME-based Transient AOO Analyses (Based on ODYNM10/TASC03, BWR/4 AOO)

Description	GESTR-M Baseline	PRIME03	Delta
[[			
			]]

(1) [[

]]

The stated minimum calculated margin to the fuel centerline melt (thermal overpower) and the cladding strain (mechanical overpower) criteria in Section 2.8.5.2.1 of Reference 4 is [[ ]]. With an expected [[ ]] there remains significantly more than the 10% minimum margin specified in Limitations and Conditions 9.9 and 9.11 of Reference 9.

Table 4 - Comparison of GESTR-M-based versus PRIME-based ATWS Analysis Results (Based on ODYNV09/TASC03, BWR/5 ATWS)

Description	GESTR-M Baseline	PRIME03	Delta
[[			
			]]

(1) [[
]]

After applying the largest expected change due to PRIME implementation, an [[
]], to the Reference 4 Table 2.8-8 PCT result of 1342°F, there is still significant margin to the PCT limit and ATWS PCT continues to be bounded by LOCA.

Continued PBAPS EPU acceptability to other ATWS acceptance criteria with the implementation of PRIME is confirmed. Impact on other ATWS acceptance criteria are as follows:

- Reactor Vessel Integrity – [[ ]].
- Containment integrity – [[ ]] – Large margin exists to the PBAPS containment acceptance criteria of 56 psig and 180°F.
- Local Cladding Oxidation – [[ ]]. The PBAPS EPU ATWS fuel temperature with the implementation of PRIME will remain well below 1600°F.

Note that cycle specific PBAPS analyses of AOO events using full PRIME implementation will be performed prior to EPU implementation.

References:

1. Information Notice (IN) 2011-21, "Realistic Emergency Core Cooling System Evaluation Model Effects Resulting from Nuclear Fuel Thermal Conductivity Degradation" (Agencywide Document Access and Management System (ADAMS) Accession No. ML113430785).

2. Robert A. Nelson (Deputy Director Division of Policy and Rulemaking Office of Nuclear Reactor Regulation Unites States Nuclear Regulatory Commission) to J. Head (GEH), "Final Safety Evaluation for GE HITACHI Nuclear Energy Americas Topical Report NEDO-33173, Supplement 4, "Implementation Of Prime Models and Data In Downstream Methods" (TAC NO. ME1704), dated September 9, 2011.

3. Sher Bahadur, Deputy Director Division of Policy and Rulemaking Office of Nuclear Reactor Regulation to J. Head (GEH), "NRC Audit of GE-Hitachi Nuclear Energy Americas Topical Report NEDO-33173, Supplement 4-A, "Implementation Of Prime Models and Data In Downstream Methods" (TAC NO. ME9033)," dated October 22, 2012.

4. 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.

5. Letter from K. F. Borton (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "Supplemental Information and Corrections Supporting Request for License Amendment Request – Extended Power Uprate – Supplement No. 1," dated February 15, 2013. (ML13051A032), Attachments 5 and 6.

6. Jason S. Post (GEH) to U.S. Nuclear Regulatory Commission Document Control Desk, "Part 21 Notification: Adequacy of GE Thermal-Mechanical Methodology, GSTRM," MFN-07-040, January 21, 2007.

7. Global Nuclear Fuel, "The PRIME Model for Analysis of Fuel Rod Thermal-Mechanical Performance, NEDC-33256P-A, NEDC-33257P-A and NEDC-33258P-A," Revision 1, September 2010.

8. GE Hitachi Nuclear Energy, "Implementation of PRIME Models and Data in Downstream Methods," NEDO-33173, Supplement 4A, Revision 1, November 2012.

9. GE Hitachi Nuclear Energy, "Applicability of GE Methods to Expanded Operating Domains," NEDC 33173P-A, Revision 4, November 2012.

10. GE Nuclear Energy, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," NEDO-32465-A, August 1996.

Enclosure 1

PBAPS EPU (Rated Core Flow)
with PRIME Model input incorporated

ECCS-LOCA
Small Break (0.05 ft^2)

(Compare to Reference 5, LAR Reference Case #6)

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[[

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[[

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Enclosure 2

**PBAPS EPU (Rated Core Flow)
with PRIME Model input incorporated**

**ECCS-LOCA
Large Break (DBA, DEG)**

(Compare to Reference 5, LAR Reference Case #5)

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