UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 21, 2013

Mr. Michael J. Pacilio
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 - ISSUANCE OF AMENDMENTS RE: USE OF NEUTRON ABSORBING INSERTS IN SPENT FUEL POOL STORAGE RACKS (TAC NOS. ME7538 AND ME7539)

Dear Mr. Pacilio:

The Commission has issued the enclosed Amendment Nos. 287 and 290 to Renewed Facility Operating License Nos. DPR-44 and DPR-56 for Peach Bottom Atomic Power Station, Units 2 and 3. These amendments consist of changes to the Technical Specifications (TSs) and Facility Operating Licenses (FOLs) in response to your application dated November 3, 2011, as supplemented by letters dated December 22, 2011, April 4, 2012, May 17, 2012, June 21, 2012, August 15, 2012, November 13, 2012, and April 18, 2013.

The amendments modify the TSs and FOLs to allow the use of neutron absorbing inserts in the spent fuel pool storage racks for the purpose of criticality control in the spent fuel pools.

As discussed in Attachment 11 of your application dated November 3, 2011, you made a commitment to revise the Updated Final Safety Analysis Report (UFSAR) to add a description of the Rack Insert Surveillance Program. The Nuclear Regulatory Commission (NRC) staff has added the following words as a condition of the amendment to ensure that the UFSAR is revised as part of the amendment implementation:

> Implementation of the amendment shall include revision of the Updated Final Safety Analysis Report as described in Attachment 11 to the licensee's letter dated November 3, 2011.

The above implementation statement was discussed with Mr. Tom Loomis of your staff on April 30, 2013.

Enclosure 4 transmitted herewith contains sensitive unclassified information
When separated from Enclosure 4, this document is decontrolled.

The NRC staff has determined that its safety evaluation (SE) for the subject amendments contains proprietary information pursuant to Title 10 of the *Code of Federal Regulations,* Section 2.390. Accordingly, the NRC staff has prepared a redacted, publicly available, non-proprietary version of the SE. Both versions of the SE are enclosed. Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

RB Ennis

Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-277 and 50-278

Enclosures:
1. Amendment No. 287 to Renewed DPR-44
2. Amendment No. 290 to Renewed DPR-56
3. Non-Proprietary SE
4. Proprietary SE

cc w/encls 1, 2, and 3: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

EXELON GENERATION COMPANY, LLC

PSEG NUCLEAR LLC

DOCKET NO. 50-277

PEACH BOTTOM ATOMIC POWER STATION, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 287
Renewed License No. DPR-44

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Exelon Generation Company, LLC (Exelon Generation Company), and PSEG Nuclear LLC (the licensees), dated November 3, 2011, as supplemented by letters dated December 22, 2011, April 4, 2012, May 17, 2012, June 21, 2012, August 15, 2012, November 13, 2012, and April 18, 2013, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

Enclosure 1

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C(2) of Renewed Facility Operating License No. DPR-44 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 287, are hereby incorporated in the renewed license. Exelon Generation Company shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days. Implementation of the amendment shall include revision of the Updated Final Safety Analysis Report as described in Attachment 11 to the licensee's letter dated November 3, 2011.

FOR THE NUCLEAR REGULATORY COMMISSION

Veronica M. Rodriguez, Acting Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Technical Specifications and Facility Operating License

Date of Issuance: May 21, 2013

ATTACHMENT TO LICENSE AMENDMENT NO. 287

RENEWED FACILITY OPERATING LICENSE NO. DPR-44

DOCKET NO. 50-277

Replace the following pages of the Renewed Facility Operating License with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
3	3
7a	7a
8	8

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

Remove	Insert
4.0-2	4.0-2

(5) Exelon Generation Company, pursuant to the Act and 10 CFR Parts 30 and 70, to possess, but not to separate, such byproduct and special nuclear material as may be produced by operation of the facility, and such Class B and Class C low-level radioactive waste as may be produced by the operation of Limerick Generating Station, Units 1 and 2.

C. This renewed license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Section 50.54 of Part 50, and Section 70.32 of Part 70; all applicable provisions of the Act and the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified below:

(1) Maximum Power Level

Exelon Generation Company is authorized to operate the Peach Bottom Atomic Power Station, Unit 2, at steady state reactor core power levels not in excess of 3514 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 287, are hereby incorporated in the license. Exelon Generation Company shall operate the facility in accordance with the Technical Specifications.

(3) Physical Protection

Exelon Generation Company shall fully implement and maintain in effect all provisions of the Commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provisions of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822), and the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans[1], submitted by letter dated May 17, 2006, is entitled: "Peach Bottom Atomic Power Station Security Plan, Training and Qualification Plan, Safeguards Contingency Plan, and Independent Spent Fuel Storage Installation Security Program, Revision 3." The set contains Safeguards Information protected under 10 CFR 73.21.

Exelon Generation Company shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The Exelon Generation Company CSP was approved by License Amendment No. 283.

(4) Fire Protection

The Exelon Generation Company shall implement and maintain in effect all provisions of the approved fire protection program as described in the Updated Final Safety Analysis Report for the facility, and as approved in the NRC Safety Evaluation Report (SER) dated May 23, 1979, and Supplements dated August 14, September 15, October 10 and November 24, 1980, and in the NRC SERs dated September 16, 1993, and August 24, 1994, subject to the following provision:

[1] The Training and Qualification Plan and Safeguards Contingency Plan are Appendices to the Security Plan.

(b) The first performance of the periodic assessment of CRE habitability, Specification 5.5.13.c(ii), shall be within 3 years, plus the 9-month allowance of SR 3.0.2, as measured from October 25, 2004, the date of the most recent successful tracer gas test, as stated in the January 21, 2005 letter response to Generic Letter 2003-01, or within the next 9 months if the time period since the most recent successful tracer gas test is greater than 3 years.

(c) The first performance of the periodic measurement of CRE pressure, Specification 5.5.13.d, shall be within 24 months, plus the 180 days allowed by SR 3.0.2, as measured from the date of the most recent successful pressure measurement test, or within 180 days if not performed previously.

(14) Spent Fuel Pool Criticality Considerations

(a) Use of spent fuel pool storage cells without NETCO-SNAP-IN® rack inserts shall be restricted as follows:

1) Minimum panel Boron-10 areal density of a storage cell shall be greater than or equal to 0.014 grams per square centimeter to store fuel assemblies with the maximum in-core cold k-infinity of up to 1.235. The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

2) A storage cell shall not contain any fuel assembly if the minimum panel Boron-10 areal density of a storage cell is less than 0.014 grams per square centimeter. The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

(b) Until the installation of NETCO-SNAP-IN® rack inserts are completed in the Peach Bottom Unit 2 spent fuel pool, Boraflex degradation shall be monitored analytically every 6 months.

(c) Boraflex degradation shall be monitored by in-situ testing in the Peach Bottom Unit 2 spent fuel pool no later than December 31, 2014, unless installation of the NETCO-SNAP-IN® rack inserts for Unit 2 have been completed prior to this date.

(d) Installation of NETCO-SNAP-IN® rack inserts shall be completed by December 31, 2016.

3. This renewed license is subject to the following conditions for the protection of the environment:

A. To the extent matters related to thermal discharges are treated therein, operation of Peach Bottom Atomic Power Station Unit No. 2 will be governed by NPDES Permit No. PA 0009733, as now in effect and as hereafter amended. Questions pertaining to conformance thereto shall be referred to and shall be determined by the NPDES Permit issuing or enforcement authority, as appropriate.

B. In the event of any modification of the NPDES Permit related to thermal discharges or the establishment (or amendment) of alternative effluent limitations established pursuant to Section 316 of the Federal Water Pollution Control Act, the Exelon Generation Company shall inform the NRC and analyze any associated changes in or to the Station, its components, its operation or in the discharge of effluents therefrom. If such change would entail any modification to this license, or any Technical Specifications which are part of this license, or require NRC approval pursuant to 10 CFR 50.59 or involve an environmental impact different than analyzed in the Final Environmental Statement, the Exelon Generation Company shall file with the NRC, as applicable, an appropriate analysis of any such change on facility safety, and/or an analysis of any such change on the environmental impacts and on the overall cost-benefit balance for facility operation set forth in the Final Environmental Statement and a request for an amendment to the operating license, if required by the Commission's regulations. As used in this Condition 3.B, Final Environmental Statement (FES) means the NRC Staff Final Environmental Statement related to Operation of Peach Bottom Atomic Power Station Units Nos. 2 and 3 dated April 1973, as modified by (1) the Initial Decision of the Atomic Safety and Licensing Board dated September 14, 1973, (2) the Supplemental Initial Decision of the Atomic Safety and Licensing Board dated June 14, 1974, (3) the Decision of the Atomic Safety and Licensing Appeal Board dated July 5, 1974, (4) the Memorandum and Order of the Commission dated August 8, 1974, (5) any further modification resulting from further review by the Appeal Board and by the Commission, if any, and (6) any Environmental Impact Appraisal which has been or may be issued by the NRC since the FES was published in April 1973.

4. This renewed license is effective as of the date of issuance and shall expire at midnight on August 8, 2033.

FOR THE UNITED STATES
NUCLEAR REGULATORY
COMMISSION

/RA/

Samuel J. Collins, Director
Office of Nuclear Reactor Regulation

Attachments:
Appendices A and B
Technical Specifications

Date of Issuance: May 7, 2003

4.0 DESIGN FEATURES (continued)

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

a. Fuel assemblies having a maximum k-infinity of 1.270 in the normal reactor core configuration at cold conditions;

b. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 10.3 of the UFSAR;

c. A nominal 6.280 inch center to center distance between fuel assemblies placed in the storage racks; and

d. The installed neutron absorbing rack inserts having a Boron-10 areal density ≥ 0.0102 g/cm^2.

4.3.1.2 The new fuel storage racks shall not be used for fuel storage. The new fuel shall be stored in the spent fuel storage racks.

4.3.2 Drainage

The spent fuel storage pool is designed and shall be maintained to prevent inadvertent draining of the pool below plant elevation 219 ft.

4.3.3 Capacity

The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 3819 fuel assemblies.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

EXELON GENERATION COMPANY, LLC

PSEG NUCLEAR LLC

DOCKET NO. 50-278

PEACH BOTTOM ATOMIC POWER STATION, UNIT 3

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 290
Renewed License No. DPR-56

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Exelon Generation Company, LLC (Exelon Generation Company), and PSEG Nuclear LLC (the licensees), dated November 3, 2011, as supplemented by letters dated December 22, 2011, April 4, 2012, May 17, 2012, June 21, 2012, August 15, 2012, November 13, 2012, and April 18, 2013, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C(2) of Renewed Facility Operating License No. DPR-56 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 290, are hereby incorporated in the renewed license. Exelon Generation Company shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days. Implementation of the amendment shall include revision of the Updated Final Safety Analysis Report as described in Attachment 11 to the licensee's letter dated November 3, 2011.

FOR THE NUCLEAR REGULATORY COMMISSION

Veronica M. Rodriguez, ~~Acting~~ Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the License and Technical Specifications

Date of Issuance: May 21, 2013

ATTACHMENT TO LICENSE AMENDMENT NO. 290

RENEWED FACILITY OPERATING LICENSE NO. DPR-56

DOCKET NO. 50-278

Replace the following pages of the Renewed Facility Operating License with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
3	3
7a	7a
- - -	7b

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

Remove	Insert
4.0.2	4.0.2

(5) Exelon Generation Company, pursuant to the Act and 10 CFR Parts 30 and 70, to possess, but not to separate, such byproduct and special nuclear material as may be produced by operation of the facility, and such Class B and Class C low-level radioactive waste as may be produced by the operation of Limerick Generating Station, Units 1 and 2.

C. This renewed license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Section 50.54 of Part 50, and Section 70.32 of Part 70; all applicable provisions of the Act and the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified below:

(1) Maximum Power Level

Exelon Generation Company is authorized to operate the Peach Bottom Atomic Power Station, Unit No. 3, at steady state reactor core power levels not in excess of 3514 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 290, are hereby incorporated in the license. Exelon Generation Company shall operate the facility in accordance with the Technical Specifications.[1]

(3) Physical Protection

Exelon Generation Company shall fully implement and maintain in effect all provisions of the Commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provisions of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822), and the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans[2], submitted by letter dated May 17, 2006, is entitled: "Peach Bottom Atomic Power Station Security Plan, Training and Qualification Plan, Safeguards Contingency Plan, and Independent Spent Fuel Storage Installation Security Program, Revision 3." The set contains Safeguards Information protected under 10 CFR 73.21.

Exelon Generation Company shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The Exelon Generation Company CSP was approved by License Amendment No. 283.

[1]Licensed power level was revised by Amendment No. 250, dated November 22, 2002, and will be implemented following the 14th refueling outage currently scheduled for Fall 2003.

[2]The training and Qualification Plan and Safeguards Contingency Plan and Appendices to the Security Plan.

tracer gas test, as stated in the January 21, 2005 letter response to Generic Letter 2003-01, or within the next 18 months if the time period since the most recent successful tracer gas test is greater than 6 years.

(b) The first performance of the periodic assessment of CRE habitability, Specification 5.5.13.c(ii), shall be within 3 years, plus the 9-month allowance of SR 3.0.2, as measured from October 25, 2004, the date of the most recent successful tracer gas test, as stated in the January 21, 2005 letter response to Generic Letter 2003-01, or within the next 9 months if the time period since the most recent successful tracer gas test is greater than 3 years.

(c) The first performance of the periodic measurement of CRE pressure, Specification 5.5.13.d, shall be within 24 months, plus the 180 days allowed by SR 3.0.2, as measured from the date of the most recent successful pressure measurement test, or within 180 days if not performed previously.

(14) Spent Fuel Pool Criticality Considerations

(a) Use of spent fuel pool storage cells without NETCO-SNAP-IN® rack inserts shall be restricted as follows:

1) Minimum panel Boron-10 areal density of a storage cell shall be greater than or equal to 0.014 grams per square centimeter to store fuel assemblies with the maximum in-core cold k-infinity of up to 1.235 (except as noted in a.3 below for restricted cells). The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

2) A storage cell shall not contain any fuel assembly if the minimum panel Boron-10 areal density of a storage cell is less than 0.014 grams per square centimeter (except as noted in a.3 below for restricted cells). The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

3) For the period up to December 31, 2013, cells whose minimum panel Boron-10 areal density is between 0.014 grams per square centimeter and 0.0112 grams per square centimeter may be used as restricted cells. Restricted cells will only contain Peach Bottom Unit 3 GE14 fuel assemblies with an assembly average burnup of greater than 47,400 megawatt days per metric ton. The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

(b) Until the installation of NETCO-SNAP-IN® rack inserts are completed in the Peach Bottom Unit 3 spent fuel pool, Boraflex degradation shall be monitored analytically every 6 months.

(c) Boraflex degradation shall be monitored by in-situ testing in the Peach Bottom Unit 3 spent fuel pool no later than December 31, 2013, unless installation of the NETCO-SNAP-IN® rack inserts for Unit 3 have been completed prior to this date.

(d) Installation of NETCO-SNAP-IN® rack inserts shall be completed by December 31, 2016.

3. This renewed license is subject to the following conditions for the protection of the environment:

A. To the extent matters related to thermal discharges are treated therein, operation of Peach Bottom Atomic Power Station, Unit No. 3, will be governed by NPDES Permit No. PA 0009733, as now in effect and as hereafter amended. Questions pertaining to conformance thereto shall be referred to and shall be determined by the NPDES Permit issuing or enforcement authority, as appropriate.

B. In the event of any modification of the NPDES Permit related to thermal discharges or the establishment (or amendment) of alternative effluent limitations established pursuant to Section 316 of the Federal Water Pollution Control Act, the Exelon Generation Company shall inform the NRC and analyze any associated changes in or to the Station, its components, its operation or in the discharge of effluents therefrom. If such change would entail any modification to

4.0 DESIGN FEATURES (continued)

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

a. Fuel assemblies having a maximum k-infinity of 1.270 in the normal reactor core configuration at cold conditions;

b. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 10.3 of the UFSAR;

c. A nominal 6.280 inch center to center distance between fuel assemblies placed in the storage racks; and

d. The installed neutron absorbing rack inserts having a Boron-10 areal density ≥ 0.0102 g/cm^2.

4.3.1.2 The new fuel storage racks shall not be used for fuel storage. The new fuel shall be stored in the spent fuel storage racks.

4.3.2 Drainage

The spent fuel storage pool is designed and shall be maintained to prevent inadvertent draining of the pool below plant elevation 219 ft.

4.3.3 Capacity

The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 3819 fuel assemblies.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NOS. 287 AND 290

TO RENEWED FACILITY OPERATING LICENSE NOS. DPR-44 AND DPR-56

EXELON GENERATION COMPANY, LLC

PSEG NUCLEAR 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 3

1.0 INTRODUCTION

By application dated November 3, 2011, as supplemented by letters dated December 22, 2011, April 4, 2012, May 17, 2012, June 21, 2012, August 15, 2012, November 13, 2012, and April 18, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML113081441, ML113570208, ML12096A052, ML12139A404, ML12188A094, ML12228A474, ML12319A230, and ML131090073, respectively), Exelon Generation Company, LLC (Exelon, the licensee), requested changes to the Technical Specifications (TSs) and Facility Operating Licenses (FOLs) for Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3.

The proposed license amendment would allow the use of neutron absorbing inserts in the spent fuel pool (SFP) storage racks for the purpose of criticality control in the SFPs. Specifically, the amendment would modify TS 4.3, "Fuel Storage," and add a new license condition 2.C(14) to support the installation of NETCO-SNAP-IN® neutron absorbing inserts into the individual cells of the existing PBAPS SFP storage racks. The installation of the NETCO-SNAP-IN® inserts is being undertaken by the licensee to address the degradation of the current neutron absorbing material (Boraflex) used in the PBAPS SFP racks. The rack inserts are manufactured by NETCO using Rio Tinto Alcan material.

The supplements dated December 22, 2011, April 4, 2012, May 17, 2012, June 21, 2012, August 15, 2012, November 13, 2012, and April 18, 2013, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the Nuclear Regulatory Commission (NRC or the Commission) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on June 5, 2012 (77 FR 33247).

2.0 REGULATORY EVALUATION

2.1 Background

The construction permit for PBAPS, Units 2 and 3, was issued by the Atomic Energy Commission (AEC) on January 31, 1968. As discussed in Appendix H to the PBAPS Updated Final Safety Analysis Report (UFSAR), during the construction/licensing process, both units were evaluated against the then-current AEC draft of the 27 General Design Criteria (GDC) issued in November 1965. On July 11, 1967, the AEC published for public comment, in the *Federal Register* (32 FR 10213), a revised and expanded set of 70 draft GDC (hereinafter referred to as the "draft GDC"). Appendix H of the PBAPS UFSAR contains an evaluation of the design basis of PBAPS, Units 2 and 3, against the draft GDC. The licensee concluded that PBAPS, Units 2 and 3, conforms to the intent of the draft GDC.

On February 20, 1971, the AEC published in the *Federal Register* (36 FR 3255) a final rule that added Appendix A to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "General Design Criteria for Nuclear Power Plants" (hereinafter referred to as the "final GDC"). Differences between the draft GDC and final GDC included a consolidation from 70 to 64 criteria. As discussed in the NRC's Staff Requirements Memorandum for SECY-92-223, dated September 18, 1992 (ADAMS Accession No. ML003763736), the Commission decided not to apply the final GDC to plants with construction permits issued prior to May 21, 1971. At the time

of promulgation of Appendix A to 10 CFR Part 50, the Commission stressed that the final GDC were not new requirements and were promulgated to more clearly articulate the licensing requirements and practice in effect at that time. Each plant, licensed before the final GDC were formally adopted, was evaluated on a plant-specific basis, determined to be safe, and licensed by the Commission.

The licensees for PBAPS, Units 2 and 3, have made changes to the facility over the life of the plant that may have invoked the final GDC. The extent to which the final GDC have been invoked can be found in specific sections of the UFSAR and in other plant-specific design and licensing basis documentation.

2.2 Regulatory Requirements

Based on a review of: (1) UFSAR Section 10.3; (2) UFSAR Appendix H; (3) NUREG-0800, Standard Review Plan (SRP) Section 9.1.2, Draft Revision 4, "Spent Fuel Storage" (ADAMS Accession No. ML052070503); and (4) Section 4.1 of Attachment 1 of the licensee's application dated November 3, 2011, the NRC staff identified the following regulatory requirements as being applicable to the proposed amendment:

- Draft GDC 1, "Quality Standards," which requires, in part, that those system and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation of their consequences shall be identified and then designed, fabricated, and erected to quality standards that reflect the importance of the safety function to be performed.

- Draft GDC 2, "Performance Standards," which requires, in part, that those systems and components of reactor facilities which are essential to the prevention of accidents which could affect the public health and safety or to mitigation of their consequences shall be designed, fabricated, and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice, and other local site effects.

- Draft GDC 40, "Missile Protection," which requires that protection for engineered safety features be provided against dynamic effects and missiles that might result from plant equipment failures.

- Final GDC 62, "Prevention of criticality in fuel storage and handling," which requires that criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.

- 10 CFR 50.68, "Criticality accident requirements," paragraph (b)(4), which requires, in part, that if no credit for soluble boron is taken, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95% probability, 95% confidence level, if flooded with unborated water.

2.3 Guidance Documents

The regulatory guidance for design modifications of the SFP and storage racks are documented in the NRC Office of Technology (OT) Position Paper, "OT Position For Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978 (ADAMS Accession No. ML031280383), amended by an NRC letter dated January 18, 1979 (ADAMS Accession No. ML031290521) (subsequently renamed NRC Generic Letters 78-11 and 79-04; respectively); and SRP Section 3.8.4, Draft Revision 2, "Other Seismic Category I Structures," including Appendix D to SRP Section 3.8.4, "Technical Position on Spent Fuel Racks" (ADAMS Accession No. ML052070327).

Regulatory Guide (RG) 1.29, Revision 4, "Seismic Design Classification" (ADAMS Accession No. ML070310052), provides guidance with respect to the requirements regarding structures, systems, and components (SSCs) which must be designed to withstand the effects of the loads resulting from a safe-shutdown earthquake (SSE) and remain functional following an SSE; these are designated as Seismic Category I SSCs. Specifically, 1.I of Part C, "Regulatory Position," in RG 1.29 states that the SFP structure, including the spent fuel racks, are designated as Seismic Category I. The licensee stated in Section 3.1.3 of Attachment 1 to its application dated November 3, 2011, that the NETCO-SNAP-IN® inserts are intended to become an integral part of the existing PBAPS spent fuel racks. As such, a portion of the NRC staff's review of the seismic and structural aspects of the proposed amendment focused on determining whether the licensee adequately demonstrated that the inserts have been adequately designed to withstand the loads induced by an SSE and remain functional (i.e., Seismic Category I).

Consistent with the guidance in SRP 9.1.2, Draft Revision 4, the NRC staff's review should ensure that there are no potential mechanisms that will: (1) alter the dispersion of the strong fixed neutron absorbers incorporated in the design of the storage racks, and/or (2) cause physical distortion of the tubes retaining the stored fuel assemblies.

On September 29, 2011, the NRC staff issued Interim Staff Guidance (ISG) DSS-ISG-2010-1, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," (ADAMS Accession No. ML110620086). This ISG provides updated review guidance to the NRC staff to address the increased complexity of SFP license applications. The staff used this ISG for review of the proposed amendment.

3.0 TECHNICAL EVALUATION

The NRC staff review focused on the following areas: (1) structural integrity; (2) use of Rio Tinto Alcan material; and (3) criticality analysis. These 3 areas are discussed in safety evaluation (SE) Sections 3.1, 3.2, and 3.3, respectively.

3.1 Structural Integrity

There are two SFPs at PBAPS; one for each unit. In accordance with TS 4.3.3, each unit's SFP is designed and maintained with a storage capacity limited to no more than 3,819 fuel assemblies. This capacity was established by Amendments 116 and 120 issued to PBAPS Units 2 and 3, respectively, by the NRC's letter dated February 19, 1986 (ADAMS Accession No.

ML011360516). These amendments changed the PBAPS TSs to permit storage of up to 3,819 fuel assemblies in each unit's SFP through the installation of high-density spent fuel storage racks. Each unit's SFP contains fifteen spent fuel storage racks of varying capacities, from 126 storage cells to 380 storage cells. The stainless steel storage racks are free-standing, "egg-crate" structures composed of individual cells which are interconnected to form an integral array configuration. The racks were originally manufactured with a sheet of Boraflex neutron absorbing material which is located on the cell outer surfaces and held in place by stainless steel wrappers welded to the cells. The NETCO-SNAP-IN® inserts are being installed in the PBAPS spent fuel storage racks in response to current concerns regarding Boraflex degradation and subsequent decrease in neutron absorbing capability, as documented in NRC GL 96-04 (ADAMS Accession No. ML031110008).

The NETCO-SNAP-IN® neutron absorbing inserts are designed to be an integral part of the existing PBAPS spent fuel racks and are depicted graphically in Attachment 3 and Figure 2-1 of Attachment 5 to the licensee's November 3, 2011, submittal. Physically, the inserts are 0.075 inch-thick, are chevron shaped and have a vertical length which is equal to the cell height of the existing PBAPS spent fuel racks (169 inches). The aluminum and boron carbide composite inserts function by maintaining a greater than 90 degree bend angle when formed, but are subsequently compressed to a 90 degree bend angle when installed in the individual spent fuel rack cells. By compressing the inserts to fit within the cells, the inserts assume a bearing force against the inside of the cell walls which retains the inserts in place.

The scope of review for SE Section 3.1 pertains to the structural integrity of the SSCs affected by the proposed amendment with respect to the proposed installation of NETCO-SNAP-IN® neutron absorbing inserts. These affected SSCs include the NETCO-SNAP-IN® inserts themselves, the existing spent fuel racks, and the SFP structure, including the SFP liner. Specifically, the review focused on the following: (1) the seismic and structural integrity of the NETCO-SNAP-IN® inserts proposed for installation at PBAPS (SE Section 3.1.1); (2) the potential impact of the installation of the inserts on the existing SFP storage racks at PBAPS, including an assessment of the effects of insert installation on mechanical fuel handling accidents (SE Section 3.1.2); and (3) the potential impact of the installation of the inserts on the PBAPS SFP structure itself, including the SFP walls, slab and stainless steel liner (SE Section 3.1.3).

3.1.1 Neutron Absorbing Inserts

The NRC staff's assessment of the structural and seismic aspects of the NETCO-SNAP-IN® neutron absorbing inserts focused on the performance and integrity of the inserts during normal and abnormal loading conditions. Given that the inserts will become an integral part of the existing PBAPS spent fuel racks and thus classified as Seismic Category I, much of the NRC staff's review focused on the ability of the inserts to maintain their intended configuration and continue performing their intended safety function under design basis seismic loading conditions (i.e., SSE). The licensee's approach to demonstrate acceptable structural and seismic performance of the insert was based on a combination of analysis and testing. Additionally, the licensee plans to monitor the structural performance of the inserts by using surveillance coupons throughout the life of the inserts.

Evaluations and Testing

The licensee performed analytical and confirmatory numerical analyses to evaluate the stresses induced in the inserts during installation. The licensee stated that the results of the stress analysis demonstrated that the stresses in the inserts remained below the insert material ultimate stress limit. In response to an NRC staff request for additional information (RAI) requesting justification for using the ultimate stress as an acceptable stress limit for the inserts, the licensee clarified its response by noting that the analyses performed for the inserts showed some discrete instances of plastic deformation, particularly in the wing and bend sections of the insert. Nonetheless, the licensee stated that sufficient elastic margin exists in the inserts, such that adequate retention force is maintained between the insert and cell walls. Further, the licensee stated that testing of the inserts (as discussed below), demonstrates that any plastic deformation does not prevent the insert from maintaining a sufficient amount of retention force within the spent fuel rack cells. The NRC staff concludes that the licensee's justification regarding the use of ultimate stress as an acceptance criterion is acceptable based on the fact that rigorous testing activities allow the licensee to confirm that any plastic deformation induced by installation does not inhibit the functionality of the inserts.

During the licensee's clean pool testing activities, the licensee established a minimum removal force criterion of 200 pounds-force (lbf), a maximum installation force criterion of 800 lbf, and a maximum drag force criterion of 75 lbf. Section 3.4.4 of Attachment 1 to the licensee's application dated November 3, 2011, documents the details of the demonstration program undertaken by the licensee to measure these insertion, drag and withdrawal forces. The licensee provided supplemental discussion regarding the demonstration program by letter dated December 22, 2011, and noted that the demonstration program was undertaken using full-scale test cells which were fabricated according to the PBAPS spent fuel rack specifications.

The demonstration program results were used to show that adequate retention force is maintained by the inserts, such that they remain in place during normal (i.e., fuel handling) and abnormal (i.e., design-basis seismic event) loading conditions. While the insert does not appreciably reduce the mechanical clearance within a rack cell due to its small thickness, the licensee's demonstration program included an assessment of the mechanical design criteria to ensure that any reduced clearance would not have an effect on the normal fuel handling activities undertaken at PBAPS. The NRC staff notes that for the normal loading conditions during fuel handling activities, the licensee also relies on hoist load cell readings for situations where a fuel assembly may be dragging on an insert due to a warping or bowing of the insert. This is conveyed in Section 3.4.1 of Attachment 1 to the licensee's application dated November 3, 2011, whereby the licensee states that the hoist load cell will recognize the increased load resulting from the resistance induced by a fuel assembly dragging an insert. Additionally, the licensee notes that cells where a fuel assembly is unable to be inserted due to a lack of mechanical clearance will not be used and the fuel assembly will be de-channeled and stored.

With respect to the withdrawal testing, the results of the clean pool tests showed that the inserts maintained a static friction-based retention force between 443 lbf and 976 lbf, the range of which is well above the 200 lbf minimum removal criteria. In its submittal dated April 4, 2012, the licensee stated that, during a design-basis seismic event, the inserts must maintain at least

40.8 lbf of retention force to ensure that the insert configurations remain unchanged. However, given that the inserts are compressed from a greater than 90 degree angle to an approximate angle of 90 degrees to fit inside the individual spent fuel rack cells, the inserts are under a constant strain condition when installed in the spent fuel rack cells. Based on this consideration, the potential for stress relaxation of the inserts over time and the subsequent reduction in retention force over this period of time must be considered. By satisfying the 200 lbf minimum removal force criterion used during its demonstration program testing, the licensee notes that a 79.6% reduction in retention force due to stress relaxation still ensures that adequate retention force is available to resist the upward load induced during a design-basis seismic event (i.e., 40.8 lbf). Based on test data of stress relaxation in aluminum alloys similar to that used to manufacture the NETCO-SNAP-IN® inserts, the licensee stated that the inserts would be expected to experience a stress relaxation of approximately 50% over the 20-year lifetime of the inserts. As part of the licensee's surveillances which will be used to monitor the performance of the inserts, the licensee plans to monitor stress relaxation in the inserts throughout the lifetime of the inserts; these surveillances are described below.

In conjunction with the testing and analysis used to demonstrate satisfactory structural and seismic performance of the inserts, the licensee also intends to perform periodic testing of insert samples (coupons) to monitor the progression of stress relaxation in the insert material. Section 3.9.3 of Attachment 1 to the licensee's application dated November 3, 2011, details the Long-Term Coupon Surveillance Program which the licensee will employ to monitor the stress relaxation of the insert material, along with the performance of a number of variables associated with the inserts. In doing so, the licensee plans to use a surveillance "tree" which will be placed in the PBAPS SFP and contain a number of surveillance coupons. Twenty-four of these coupons, referred to as the "bend" coupons, will be used specifically to monitor the stress relaxation occurring in the inserts through measurement of the coupon bend radii. In the licensee's April 4, 2012, RAI response, it was stated that for the first 10 years after beginning the surveillances, one bend coupon will be removed every 2 years. Following the initial 10-year period, one coupon will be removed for stress relaxation monitoring every 4 years. The licensee stated that the acceptance criteria for stress relaxation is that the coupon must demonstrate that at least 100 pounds of retention force remains, which corresponds to 50% of the minimum required pull out force of 200 pounds (as discussed above in the licensee's retention force testing).

Seismically-Induced Impact Loads on Inserts

The licensee stated in its letter dated December 22, 2011, that the impact load of a fuel assembly on the NETCO-SNAP-IN® inserts, generated by the horizontal acceleration of a fuel assembly during a design-basis seismic event, was derived from the analyses performed to support the installation of high-density spent fuel racks at PBAPS. This calculation, WNEP-8542, "Design Report of High Density Spent Fuel Storage Racks for Philadelphia Electric Company Peach Bottom Atomic Power Station Units 2 & 3," also provided the bases for Amendments 116 and 120 issued to PBAPS Units 2 and 3, respectively, by the NRC's letter dated February 19, 1986 (discussed above in SE Section 3.1). The licensee stated that the impact loads derived in WNEP-8542 are valid for the present amendment request due to the fact that the fuel assembly weights assumed in WNEP-8542 are over 500 pounds greater than those actually present in the PBAPS SFPs. As such, WNEP-8542 assumed a fuel assembly dry

weight of 1377 pounds (1315 pounds submerged), while the NETCO analysis assumes an 800 pound dry assembly weight, both of which bound all assembly weights currently stored in the PBAPS SFP.

The stress resulting from the impact of a fuel assembly during a design-basis seismic event was determined in WNEP-8542 to be 403 pounds per square inch (psi). Based on the licensee's assertion that this number is still valid due to the bounding fuel assembly weight used in WNEP-8542, the licensee compared the stress induced in the insert to the yield stress of the NETCO-SNAP-IN® and determined that the stress does not induce any yielding in the insert. Given that the NETCO-SNAP-IN® insert yield stress is assumed as 8000 psi, the licensee concluded that deformation and subsequent failure of the insert due to seismically-induced impact loads is unlikely.

NRC Staff Evaluation

The NRC staff has reviewed the licensee's assessment of the seismic and structural aspects of the NETCO-SNAP-IN® inserts and finds the licensee's assessment acceptable, based on the following discussion. The NRC staff notes that for normal loading conditions, the licensee performed stress analyses of the insert and has undertaken successful insertion and drag testing to demonstrate adequate performance of the insert during installation and fuel handling activities. While the licensee's stress analyses of the insert showed some plastic deformation of the component during installation, the NRC staff notes that the licensee was able to demonstrate, through successful testing, that the insert will be able to perform its intended safety function, based on testing acceptance criteria which represent the limiting conditions during normal operation and abnormal conditions.

The licensee confirmed that adequate clearance is available within the spent fuel rack cells, such that fuel handling activities should not result in any impact on an installed insert. Nonetheless, the licensee acknowledged that administrative controls are in place to recognize if an insert has become warped or bowed during fuel handling activities. These administrative controls rely on the fuel handling crane hoist load cell, whereby the load cell will recognize whether an additional load has been imposed due to fuel assembly drag on an insert. For cells where fuel assemblies cannot fit due to limited clearance resulting from insert installation, the licensee confirmed that the fuel assembly will be de-channeled and stored elsewhere in the SFP. Additionally, the NRC staff notes that in the unlikely event of an inadvertent removal of an insert during fuel handling activities, the licensee has already accounted for the criticality implications of this event. The NRC staff's review of the criticality aspects of this amendment request is discussed in SE Section 3.3, below.

With respect to the abnormal loading conditions, the NRC staff notes that the insert is subjected to an upward load of 40.8 lbf. However, considering the effects of a 50% reduction in retention force due to stress relaxation, the insert must be able to resist a withdrawal force of at least 81.6 lbf. Given that the licensee's withdrawal tests demonstrated resistance to withdrawal forces well above 81.6 lbf, as discussed above, the NRC staff concludes that there is reasonable assurance regarding the ability of the insert to provide sufficient retention force against abnormal loading conditions, such that the inserts will be able to maintain their intended configuration under these conditions. Further, the NRC staff notes that the licensee's surveillance program is

capable of monitoring the effects of stress relaxation in the inserts, such that corrective actions will be taken if stress relaxation beyond 50% is measured in any of the surveillance coupons during the life of the inserts.

The NRC staff also finds the licensee's assessment of seismically-induced impact loads and their effects on the NETCO-SNAP-IN® inserts acceptable. This acceptance is based on the fact that the licensee has calculated impact loads assuming fuel assembly weights much greater than those which exist at PBAPS, suggesting that actual impact loads are likely to be much less than those assumed. Further, the NRC staff notes that even with the limiting impact loads, the stresses induced in the inserts are much less than the yield stress of the material, which suggests that there is a very low likelihood that the inserts would experience any type of damage due to impact loads generated by a seismic event. Based on the above considerations, the NRC staff concludes that there is reasonable assurance that the inserts will maintain their configuration as integral parts of the PBAPS spent fuel racks and be able to perform their intended safety functions under normal and abnormal loading conditions.

3.1.2 Spent Fuel Storage Racks

Section 10.3.4.1.3 of the PBAPS UFSAR indicates that the PBAPS SFP racks were designed to meet the criteria specified in the NRC Office of Technology (OT) Position Paper, "OT Position For Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978, amended by an NRC letter dated January 18, 1979 (subsequently renamed NRC Generic Letters 78-11 and 79-04, respectively). In accordance with the guidance in the OT Position Paper, the PBAPS spent fuel racks were designed to meet the allowable stress criteria stipulated by Subsection NF of the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (Code), Section III, Division 1. Given that the existing spent fuel racks themselves will not be modified, the NRC staff focused on verifying that the criteria to which the racks were originally designed will continue to be met following the installation of the NETCO-SNAP-IN® inserts.

To determine the stresses imparted on the cells of the existing PBAPS spent fuel racks by the inserts, the licensee stated that the limiting case involves the installation of the inserts into the cells. In its letter dated December 22, 2011, the licensee stated that the stresses imparted on the cell walls during installation would not be expected to exceed 34 psi. The governing stress condition for the racks was provided by the licensee as 7384 psi with a 9260 allowable stress, as prescribed by Subsection NF of the ASME Code. Combining the installation stress of 34 psi to the previously calculated value of 7384 psi demonstrates that installation of the inserts should have no appreciable effect on the cell wall structural integrity and the stress remains below the allowable value.

With respect to the deadweight load on the existing racks, the licensee confirmed that the WNEP-8542 calculation utilized fuel assembly weights of 1377 pounds per assembly (dry weight). As indicated previously, the weight of any existing fuel assembly at PBAPS is assumed to be no more than 800 pounds (dry weight). Combining the currently assumed assembly weight with the weight of one insert (approximate dry weight of 18.15 pounds), it is apparent that the deadweight loads calculated in WNEP-8542 sufficiently bound the loads which will be present following installation of the rack inserts. The NRC staff notes that there should be no impact on

the seismic response of the existing racks with the addition of the inserts, due to the fact that this response is directly correlated to the weight of the racks and their contents. The racks have already been evaluated assuming fuel assembly weights' which are much greater than those currently existing in the racks, including the additional weight of the inserts. As such, the dynamic response of the racks would not be expected to change and the existing analyses of record related to the stresses and displacements resulting from seismic input motions remain valid. For thermal loads, the licensee confirmed in Section 3.7 of Attachment 1 to its application dated November 3, 2011, that the maximum heat loads are not affected due to the installation of the inserts.

The NRC staff has reviewed the licensee's evaluations related to the impact of installing the NETCO-SNAP-IN® inserts in the existing PBAPS spent fuel racks and considers the licensee's assessments acceptable. This acceptance is based primarily on the following: (1) the stresses imparted on the existing rack cells during installation and normal operation do not cause stress increases above ASME Code allowable values; and (2) the current analyses of record for the existing racks use loads which bound those which will be present following installation of the racks. Notably, calculation WNEP-8542, which was developed to support the installation of the existing racks, uses fuel assembly weights which bound the combined weight of the existing fuel assemblies and NETCO-SNAP-IN® inserts. Subsequently, there is no effect on the design basis deadweight and seismic loads. The NRC staff also notes that there is no expected increase in thermal loads. As such, the NRC staff concludes that the design criteria stipulated by the OT Position Paper and stress limits prescribed by the ASME Code will continue to be satisfied following installation of the NETCO-SNAP-IN® inserts.

Fuel Handling Accidents

Section IV(1)(b) of the OT Position Paper requires licensees to assess the mechanical impacts on spent fuel storage racks resulting from postulated fuel handling accidents, including fuel assembly drops and uplift forces due to a stuck fuel assembly. Section 10.3.4.1.3 of the PBAPS UFSAR describes the evaluations performed by the licensee to assess the ability of the existing spent fuel racks to withstand the effects of these mechanical fuel handling accidents and remain functional following these postulated accidents. In its letter dated May 17, 2012, the licensee confirmed that it had considered whether installation of the inserts would affect the analyses of record related to the currently postulated fuel handling accidents. Additionally, the licensee confirmed that the inserts had no effect on these accidents and that the racks would remain capable of withstanding the effects of the currently postulated accidents. The NRC staff finds the licensee's assessment acceptable. This acceptance is based on the fact that the installation of the inserts does not reduce the ability of the cell wall or rack base plate to resist dynamic impact loads resulting from a dropped fuel assembly, nor does it affect whether a fuel assembly may become stuck at the bottom of the existing racks.

The NRC staff considered the possibility of the introduction of a previously unanalyzed fuel handling accident because the NETCO-SNAP-IN® inserts must be installed and removed with a specially designed tool; this tool is depicted in Figure 2-3 of Attachment 5 to the licensee's application dated November 3, 2011. The use of this tool raises the potential that the insert tool and insert could be dropped within the vicinity of the spent fuel storage racks, including through the cells or on top of the cells, as discussed in the fuel handling accidents previously analyzed

for PBAPS. The licensee states in its November 3, 2011, application that the combined weight of the insert tool and insert is less than 1,000 pounds. Additionally, in Section 3.8.2 of Attachment 1 to the licensee's application, the licensee confirmed that the insert removal/insert tool and the insert itself are of similar geometry and lighter than the fuel assembly and grapple device used for normal fuel handling activities. As such, a postulated fuel handling accident involving the tool and insert are bounded by the fuel handling accidents, as discussed above. The NRC staff finds the licensee's justification regarding this potential fuel handling accident acceptable, given that the licensee has demonstrated that the consequences of a postulated drop of the NETCO-SNAP-IN® insert tool and insert are bounded by those mechanical accidents previously analyzed due to similarities in geometries and the lower weight afforded by the insert and insert tool. As such, the NRC staff concludes that any damage sustained by the racks in a drop accident should not be greater than that previously analyzed and found acceptable for other accidents.

3.1.3 SFP Structure

With respect to the evaluation of the impact of the proposed amendment on the PBAPS Units 2 and 3 SFPs, the NRC staff's review focused on determining whether the addition of the NETCO-SNAP-IN® neutron absorbing inserts affects the overall structural integrity of the SFP structure, including the walls, slab and liner. The high-density spent fuel storage racks at PBAPS provide a capacity of 3819 storage locations in each unit's SFP. Section C.2.7.1 of Appendix C of the PBAPS UFSAR indicates that the SFP structures were evaluated in accordance with the following codes and standards for the purposes of the installation of the aforementioned high-density spent fuel storage racks: American Concrete Institute (ACI) 318-83, "Building Code Requirements for Reinforced Concrete," ACI 349-80, "Code Requirements for Nuclear Safety Related Structures," and the American Institute of Steel Construction (AISC), "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" (1978). The governing load combinations considered in the design of the reinforced concrete and structural steel of the SFP structures are outlined in Section C.2.6.3 of Appendix C of the PBAPS UFSAR.

In its May 17, 2012, RAI response regarding the impact on the SFP structure, the licensee cited Westinghouse calculation WNEP-8542 (see SE Section 3.1.1. above) as the basis for demonstrating the structural adequacy of the SFP structures following installation of the neutron absorbing inserts. As indicated in the RAI response, the licensee stated that the analysis for the PBAPS Units 2 and 3 SFP structures considered a dry fuel assembly weight of 1377 pounds (wet weight of 1315 pounds) and found the structures acceptable, in accordance with the codes and standards identified above. The licensee stated that the maximum dry weight of the fuel assemblies in the PBAPS SFP is assumed to be 800 pounds per assembly. Given that the actual, maximum dry weight of the fuel assemblies currently stored at PBAPS is much less than 1377 pounds and the dry weight of the NETCO-SNAP-IN® inserts is 18.15 pounds (in each spent fuel rack cell), the licensee stated that the addition of the inserts will not affect the structural integrity of the PBAPS Units 2 and 3 SFPs. This rationale is based on the fact that the previous Westinghouse calculation has already qualified the Units 2 and 3 SFPs for a weight much greater than that which will be seen following installation of the inserts. Given that there is no increase in the design basis weight imposed on the SFP structures, there is also no impact on the seismic analysis and subsequent loads imposed on the SFP. Additionally, the licensee confirmed in its November 3, 2011, application that addition of the inserts to the PBAPS spent

fuel racks does not alter the maximum heat load (thermal condition) within the SFP. The PBAPS UFSAR indicates that the load combinations considered are based on those stipulated in SRP Section 3.8.4, RG 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)," and the those required by ACI and AISC.

The NRC staff has reviewed the information provided by the licensee regarding the structural adequacy of the PBAPS Units 2 and 3 SFPs and considers the licensee's conclusion, that the structural integrity of the SFPs is not affected by the proposed amendment, is acceptable. This acceptance is based on the fact that the licensee has previously evaluated the SFP structures for loads which are much higher than those that will be present following installation of the inserts and found those higher loads to be acceptable. The NRC staff notes that the combined dry weight of one insert and one assembly is approximately 820 pounds, which is much less than the 1377 pounds of dry weight assumed in the previous analysis for each assembly. This suggests that there is ample margin between the loads induced on the SFP structures and the code allowable limits, when considering the additional weight imposed on the structures by the inserts. Additionally, given that there is no increase in the maximum heat load experienced by the PBAPS SFP, there should be no effect on the thermal loads assumed in the current analyses of record for the PBAPS SFP structures. Combined, these result in no impact on the SFP structure design basis analyses. Therefore, the NRC staff concludes that there is reasonable assurance that the structural integrity of the PBAPS Units 2 and 3 SFPs will be adequately maintained following installation of the NETCO-SNAP-IN® neutron absorbing inserts.

3.1.4 Structural Integrity Conclusion

The NRC staff concludes that the licensee's amendment request related to the installation of the NETCO-SNAP-IN® neutron absorbing inserts is acceptable. The NRC staff concludes that the licensee provided an adequate technical justification which shows that the inserts, as an integral part of the existing spent fuel racks, will maintain their intended configuration during normal and abnormal loading conditions, such that they will be able to perform their intended safety function under these conditions. This justification was based on a combination of analysis and testing, which are further substantiated by the licensee's plan to monitor for stress relaxation in the inserts over the lifespan of the inserts.

The installation of the NETCO-SNAP-IN® inserts did not result in the need for the licensee to perform seismic or structural re-analyses of the existing spent fuel racks or SFP structures, due to the fact that the design basis analyses for the spent fuel racks and SFP structures already consider weights which are greater than the additional weight imposed on these SSCs by the addition of the inserts. Additionally, the NRC staff notes that no increase in maximum thermal loads is expected with the installation of the inserts. As such, the design bases acceptance criteria related to the existing racks and SFP structures will remain satisfied following installation of the inserts.

Based on these considerations, the NRC staff concludes that there is reasonable assurance that the structural integrity of SSCs affected by this proposed amendment will be adequately maintained following installation of the NETCO-SNAP-IN® inserts, such that all affected SSCs, including the inserts, will be able to perform their intended safety functions. The NRC staff concludes that the licensee has demonstrated that the intent of the aforementioned regulatory

requirements, related to the seismic and structural aspects of the proposed amendment, will continue to be satisfied following the installation of the NETCO-SNAP-IN® inserts.

3.2 Use of Rio Tinto Alcan Material

The PBAPS Units 2 and 3 SFPs currently rely on Boraflex as a neutron absorbing material. Degradation of Boraflex material results from irradiation of the silicon polymer matrix in the SFP environment. Because of the ongoing degradation of the Boraflex, the licensee relies on a monitoring program to ensure sufficient neutron absorbing capabilities of the material. The licensee's long-term solution to the degradation of the Boraflex is the proposed use of NETCO-SNAP-IN® rack inserts constructed of Rio Tinto Alcan composite material with 19 volume % boron carbide. The minimum certified areal density of the Rio Tinto Alcan material is 0.0105 g/cm^2. Once the proposed inserts have been installed, the licensee will no longer need to credit the Boraflex for neutron attenuation in the criticality analysis and can therefore discontinue the Boraflex monitoring program.

The Rio Tinto Alcan composite uses AA1100 alloy as a metal matrix to retain boron carbide. This is the same alloy that is used in Boral neutron absorber materials. Unlike Boral, the Rio Tinto Alcan is manufactured by mixing boron carbide powder into molten aluminum. The composite material is then formed into a billet and hot-rolled into sheets that will form the final NETCO-SNAP-IN® inserts. The resulting material is a fully dense homogenous mixture of boron carbide particles embedded in AA1100 series aluminum. The manufacturing process is similar to that of Metamic material, which the NRC staff has approved for plant-specific use in several SFPs at operating reactors.

3.2.1 Rack Insert Surveillance Program

In Section 3.9 of Attachment 1 to its application dated November 3, 2011, the licensee described a Rack Insert Surveillance Program which consists primarily of monitoring the physical properties of the Rio Tinto Alcan composite material by performing periodic physical inspection and neutron attenuation testing to confirm the ability of the material to perform its intended function. Rio Tinto Alcan material has been previously approved for use in SFP applications at the LaSalle County Station, Unit 2.

The purpose of the licensee's surveillance program is to ensure the physical and chemical properties of the Rio Tinto Alcan composite material behave in a similar manner as that described in NETCO's simulated service performance and qualification testing of the material. The coupon program will monitor how the neutron absorber material properties change over time under the radiation, chemical, and thermal environment found in the SFP. This surveillance program will provide a means to detect any significant degradation in a timely manner that will allow for implementation of corrective actions, prior to the material losing its ability to perform its intended function.

The Rack Insert Surveillance Program includes three surveillance programs as follows: the Fast Start Coupon Surveillance Program, the Long-Term Coupon Surveillance Program, and the Full Rack Insert Surveillance Inspection Program, which are discussed below.

Long-Term Coupon Surveillance Program and Full Rack Insert Surveillance Inspection Program

The long-term surveillance program will use coupon samples, made from the same material as used for rack construction, to monitor the performance of the neutron absorbing material. A total of 96 coupons will be suspended from a mounting tree that is placed in the SFP at the time of the initial rack insert installation. Each coupon will be examined, prior to insertion in the SFP, to determine an initial condition that will be compared to the coupons condition when it is removed from the pool after exposure. The coupons will be removed from the SFP, examined, and compared to the initial condition, on a prescribed schedule. These coupons will not be re-inserted into the SFP after being removed for inspection. In addition to dimensional and weight measurements, areal density testing will be performed to ensure that the boron content of the material is sufficient to perform its neutron attenuation function. Based on the proposed sampling schedule, there are a sufficient number of coupons to allow for over 80 years of surveillance. The licensee stated that the coupon tree will remain in the pool as long as the spent fuel storage racks continue to be used.

The coupon tree includes bent coupons to simulate stresses on the actual inserts, and bi-metallic coupons to simulate galvanic corrosion that may occur with stainless steel, inconel, and zircaloy in the SFP.

In Section 3.9.3 of Attachment 1 of its application dated November 3, 2011, the licensee provided the following table showing the types, number of coupons, and objectives for each of the types of coupons in the Long-Term Coupon Surveillance Program:

Coupon Type	Number	Objective
General	48	(See next Table)
Bend	24	Track effects along bend radii
Galvanic (bi-metallic)	24	Trend galvanic corrosion with 304SS, Inconel 718 and Zircaloy coupons

Section 3.9.3 of Attachment 1 of the application dated November 3, 2011, provided the following table showing the pre-examination and post-examination requirements, as well as the acceptance criteria for the Long-Term Coupon Surveillance Program:

Test	Pre-Characterization	Post-Characterization	Acceptance Criteria
Visual (high resolution digital photo)	√	√	Evidence of visual indications
Dimension	√	√	Min. thickness: 0.005 inch less than nominal thickness Length Change: Any change of +/- 0.02 inch Width Change: Any change of +/- 0.02 inch Thickness Change: Any change of +0.010 inch / -0.004 inch
Dry Weight	√	√	Any change of +/- 5%
Density	√	√	Any change of +/- 5%
Areal Density	√ on select coupons	√	0.0102 Boron-10 g/cm^2 minimum loading
Weight Loss		√	Any change of +/- 5%
Corrosion Rate		√	< 0.05 mil/yr
Microscopy		√ as required	At the discretion of the test engineer

In addition to the acceptance criteria in the table above, the licensee also has acceptance criteria for stress relaxation. As discussed in the licensee's letter dated April 4, 2012, the "Bend" coupons that are installed in the SFP will be pulled and evaluated for stress relaxation. As stated in the licensee's letter, the acceptance criterion for stress relaxation is 50% stress reduction. According to the licensee, a relaxation of 50% will maintain greater than 100 lbf retention force. The NRC staff has evaluated the stress relaxation acceptance criteria in SE Section 3.1.1, above.

Section 3.9.3 of Attachment 1 of the application dated November 3, 2011, provided the following table showing the frequency for coupon inspection as part of the the Long-Term Coupon Surveillance Program:

Coupon Type	First Ten Years	After 10 Years with Acceptable Performance
General	2 coupons every 2 years	2 coupons every 4 years
Bend	1 coupon every 2 years	1 coupon every 4 years
Galvanic Couples		
304 Stainless	1 couple every 6 years	
Zircaloy	1 couple every 6 years	
Inconel 718	1 couple every 6 years	

In addition to the coupon inspections described above, as discussed in Section 3.9.4 of Attachment 1 to the application dated November 3, 2011, as part of the "Full Rack Insert Surveillance Inspections" program, the licensee will perform camera-aided visual examinations on two rack inserts at the same frequency as the general coupon inspection schedule. The visual examinations will monitor for physical deformities such as bubbling, blistering, corrosion pitting, cracking, or flaking. The licensee stated that the examinations will pay special attention to any edge or corner defects in the rack inserts. As described in Section 3.9.4 of Attachment 1 to the application dated November 3, 2011, and in the supplement dated April 4, 2012, the licensee will also select an insert to be removed and inspected every 10 years to ensure there is no detrimental service wear. This will consist of measurements of thickness along the length of the insert. These measurements will then be compared with the as-built thickness measurements along the insert length to determine whether it has sustained uniform wear over its service life. After the inspection, the insert will not be reinstalled.

The NRC staff has evaluated the long-term surveillance program and has reasonable assurance that the program will be able to detect degradation of the NETCO-SNAP-IN® inserts before it will have an impact on the criticality analysis. The criticality analysis is evaluated in SE Section 3.3, below. The program takes into account galvanic corrosion, bend stresses, stress relaxation, service wear, and general corrosion. These are the only known possible mechanisms that may impact the NETCO-SNAP-IN® insert capability to attenuate neutrons. The tests proposed on the coupons provide the staff with reasonable assurance that any degradation mechanism postulated to date would be detected. The frequency of testing and the acceptance criteria of the coupons also provide the staff with reasonable assurance that any postulated degradation mechanism would be detected in a timely manner. In addition, the licensee is going to inspect and test the rack inserts. This provides the staff with reasonable assurance that the licensee will be confirming the results from the coupon testing with the results of the in-service racks inserts.

Fast Start Coupon Surveillance Program

In addition to the Long-Term Coupon Surveillance Program, Exelon has initiated a "Fast Start" coupon surveillance program at LaSalle. The Fast Start program is discussed in Section 3.9.2 of Attachment 1 to the licensee's application dated November 3, 2011, and in the supplement dated April 4, 2012. This program consists of 24 coupons on a string (connected with stainless steel chain) that is suspended inside of a spent fuel storage rack cell and surrounded in all adjacent cells with freshly discharged fuel. The intent is to expose the Fast Start coupons to the maximum temperature and gamma irradiation. Two of the coupons will be removed approximately every 6 months and sent to a qualified laboratory for testing, inspection, and comparison to their pre-installation condition. The Fast Start coupons will provide early performance data on the Rio Tinto Alcan composite since the coupon string has been installed prior to rack insert installation. As of September 10, 2009, the results of this program reported in the licensee's letter dated April 4, 2012, are that "[t]here was essentially no change in the Rio-Tinto Alcan composite coupons from their pre-use characterization values." The licensee indicated that the results at LaSalle may be used to inform PBAPS Units 2 and 3 as to whether there would be any unanticipated insert material performance because the pool chemistries are similar.

In the review of NETCO report NET-332-01, "Inspection and Testing of BORAL® and Fast Start Surveillance Coupons from the LaSalle County Units 1 & 2 Stations" (Attachment 2 to the licensee's letter dated April 4, 2012), the NRC staff had a question about Section 3.8. It was stated in the report that ASTM G34-72 was used to calculate the corrosion rates. ASTM G34-72 is used to calculate exfoliation corrosion rates which do not apply to AA1100 materials. In the RAI response dated June 21, 2012, the licensee stated that this was a typo and the ASTM standard used should be ASTM G31-72. The licensee stated that ASTM G31-72 specifies a corrosion test by weight loss for metals in general and is not specific to a certain metal, alloy, or mechanism (i.e., exfoliation corrosion). The NRC staff has evaluated this response and finds that the use of a general corrosion standard is more appropriate to be used to calculate corrosion rates.

The NRC staff has reviewed the results of the "Fast Start" program as described in Attachment 2 to the licensee's letter dated April 4, 2012. The staff agrees that the SFP chemistries at PBAPS are similar to LaSalle, and that the LaSalle Fast Start Coupons can be used to inform PBAPS of unanticipated insert material performance. For the long term, however, it is imperative that PBAPS maintain their own plant-specific surveillance program (i.e., Long-Term Coupon Surveillance Program discussed above) to ensure that any plant-specific SFP conditions that could affect the NETCO-SNAP-IN® rack inserts would be detected.

3.2.2 Interim Boraflex Credit

Until all of the inserts are installed in the PBAPS Units 2 and 3 SFP racks, the interim criticality analysis will still rely on Boraflex credit for subcriticality. The licensee stated that the inserts will be in place no later than December 31, 2016. Until the inserts are all in place, the licensee will be using the existing Boraflex monitoring program to monitor and mitigate the Boraflex degradation. The Boraflex monitoring program directly impacts the validity of the criticality

analysis for the period of time prior to the insert installation. The evaluation of the interim configuration and analysis is discussed below in SE Section 3.3.2.

3.2.3 Use of Rio Tinto Alcan Material Conclusion

Based on its review of the licensee's coupon sampling program and material qualification tests, the NRC staff concludes that the NETCO-SNAP-IN® rack inserts, made from Rio Tinto Alcan composite for use as a neutron absorber, are compatible with the environment of the PBAPS SFPs. Also, the staff finds the proposed surveillance program, which includes visual, physical and confirmatory tests, is capable of detecting potential degradation of the rack insert material that could impair its neutron attenuation capability. Therefore, the NRC staff concludes that the use of Rio Tinto Alcan composite, as a neutron absorber in the SFPs at PBAPS, is acceptable.

3.3 Criticality Analysis

The licensee proposes to complete the installation of the NETCO-SNAP-IN® rack inserts by December 31, 2016. As such, the licensee provided criticality analyses pertaining to: (1) the final SFP configuration with all of the rack inserts installed; and (2) the interim SFP configuration crediting the degraded Boraflex. The NRC staff's evaluation of each of these two configurations is discussed below in SE Sections 3.3.1 and 3.3.2, respectively.

3.3.1 NETCO-SNAP-IN® Credit

In Attachment 8 to the supplement dated June 21, 2012, the licensee submitted Global Nuclear Fuel (GNF) report NEDC-33672P, Revision 1, "Peach Bottom Atomic Power Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," which provides a new SFP criticality analysis, crediting the NETCO-SNAP-IN® inserts, to justify the implementation of the alternate measure for criticality control. The analysis determined a maximum k-effective of [[ ]] at a 95% probability and 95% confidence level, and provides a margin of over [[ ]] to the regulatory k-effective limit of 0.95. Based on the available margin to the regulatory limit, in conjunction with the review discussed in Sections 3.1 and 3.2 of this SE, the NRC staff finds reasonable assurance that the licensee can comply with the regulatory requirements for fuel storage criticality, stated in GDC 62 and 10 CFR 50.68, with implementation of the NETCO-SNAP-IN® inserts.

Computational Methods and Validation

GNF used two computational methods in the criticality analysis. GNF lattice design code TGBLA06 was used to calculate burned fuel compositions and the in-core k-infinity values. The burned fuel compositions were then used in MCNP-05P, the GNF proprietary version of MCNP5, to obtain fuel storage rack k-effective values. The NRC staff evaluated the use of the two methods, as discussed below.

TGBLA06A

TGBLA06A is a two-dimensional lattice design computer program for boiling-water reactor (BWR) fuel bundle analysis. It assumes that a lattice is uniform and infinitely long along the axial

direction and that the lattice geometry and material are reflecting with respect to the lattice boundary along the transverse directions. The NRC staff previously reviewed and accepted the use of TGBLA06 for BWR core depletion calculations, as part of the approval of Amendment 26 of NEDE-24011-P-A, "GESTAR II – Implementing Improved GE Steady-State Methods," for operating BWRs. The criticality analysis included an allowance for the TGBLA06 cold eigenvalue uncertainty. The NRC staff finds the use of TGBLA06A acceptable in support of the PBAPS SFP criticality analysis.

MCNP-05P

MCNP is a generally accepted code used for criticality analyses, provided it is properly validated. ISG DSS-ISG-2010-1 references NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," for guidance on criticality code validation. NUREG/CR-6698 outlines the basic elements of validation, including identification of operating conditions and parameter ranges to be validated, selection of critical benchmarks, modeling of benchmarks, statistical analysis of results, and determination of the area of applicability.

NUREG/CR-6698 states that:

> In general, the critical experiments selected for inclusion in the validation must be representative of the types of materials, conditions, and operating parameters found in the actual operations to be modeled using the calculational method. A sufficient number of experiments with varying experimental parameters should be selected for inclusion in the validation to ensure as wide an area of applicability as feasible and statistically significant results.

The analysis used MCNP-05P with [[ ]] neutron cross section library. The MCNP-05P validation included comparisons of MCNP-05P calculated k-effective values with [[ ]]. The critical experiments included low-enriched Uranium dioxide or mixed oxide pin lattice configurations and data from NUREG/CR-6979, "Evaluation of the French Haut Taux de Combustion (HTC) Critical Experiment Data." The use of the HTC experiments documented in NUREG/CR-6979 is important in addressing the actinide distribution of burned fuel. These experiments use fuel that was specifically tailored to match this actinide distribution. The NRC staff finds that the implementation of the HTC experiments in this application is acceptable.

The licensee identified the area of applicability for the validation (e.g., fissile isotope, enrichment of fissile isotope, fuel chemical form, types of neutron absorbers, moderators and reflectors, range of moderator to fissile isotope, and physical configurations). [[

]] The statistical analysis of the calculated k-effective values showed that the data was normally distributed and that there was no presence of statistically significant trends.

[[

]] The NRC staff finds that the approach used to determine the uncertainty and the derived value is appropriate.

Based on the above, the NRC staff finds that the licensee provided sufficient information to justify the use of MCNP-05P in support of the PBAPS SFP criticality analysis.

Design-Basis Lattice Selection

Section 5.3 and Appendix B of NEDC-33672P discuss the design-basis lattice selection. The licensee provided an analysis of the spent fuel storage racks based on the GNF2 fuel design. The licensee also provided a comparative analysis showing that the limiting GNF2 lattice design selected to set the TS limit bounds all legacy fuel stored at PBAPS.

The design-basis lattice was determined from the TGBLA06A lattice depletion calculations. The core depletion parameters used to deplete the lattices cover the range of expected reactor operating conditions in terms of [[ ]] The possibility of core depletion with parameters outside the normal range was also considered and their effects on reactivity were addressed. The lattice selection process included an analysis of [[ ]] lattices with variable lattice parameters such as exposure, enrichment, void fractions, number of Gadolinium (Gd) rods, and Gd enrichments. The licensee calculated the peak in-core eigenvalues and the corresponding in-rack eigenvalues for each of the [[ ]] lattices. The lattice corresponding to the highest in-rack k-effective was chosen as the design-basis lattice.

Bias and Uncertainty Analysis

Tables 12, 13, and 14 of NEDC-33672P provide the biases and uncertainties used to determine the maximum in-rack k-effective at a 95% probability and 95% confidence. Biases are arithmetically added to the calculated k-effective to account for conditions not directly modeled in the base case analysis. For the proposed amendment, the licensee included biases [[ ]] The biases also covered additional configurations such as [[ ]] The NRC staff finds that the licensee provided an acceptably comprehensive analysis of the biases.

Uncertainty components are statistically summed and then added to the calculated k-effective. For the proposed amendment, the uncertainties included manufacturing tolerances as well as computational uncertainties. The manufacturing tolerances included uncertainties on [[ ]] The computational uncertainties addressed the [[ ]] The NRC staff finds that the licensee has properly accounted for the uncertainties.

Abnormal or Accident Conditions

The licensee considered the following abnormal or accident conditions in the PBAPS SFP criticality analysis.

1. Missing NETCO-SNAP-IN® insert,
2. Dropped fuel,
3. Damaged fuel,
4. No NETCO-SNAP-IN® inserts on rack periphery,
5. Misplacement of a fuel assembly,
6. Lateral movement of a rack module,
7. Loss of SFP cooling, and
8. Inaccessible storage locations.

The [[ ]] scenario resulted in the bounding abnormal or accident condition with an impact of about [[ ]] In addition, the licensee explicitly analyzed and determined the reactivity increase associated for the following scenarios: damaged fuel, no NETCO-SNAP-IN® inserts on rack periphery, and misplaced assembly. In the maximum k-effective determination, the licensee accounted for these abnormal or accident conditions by [[ ]] The misloaded fuel assembly was not explicitly analyzed, but this accident is bounded by the base case model which assumes an infinite array of storage cells with no axial or radial leakage. Dropping a fuel bundle on a storage rack is non-bounding for criticality since minimum separation will preclude neutron interactions between the dropped assembly and the fuel present in the rack. The laterally infinite model bounds the configuration that may result from a lateral movement of a rack module. The licensee has addressed the reactivity effect due to an increase in moderator temperature that may result from a loss of SFP cooling. Finally, the licensee has quantitatively shown that the base case infinite model bounds the PBAPS pool configuration, where the inaccessible storage cells contain no assembly and no NETCO-SNAP-IN® insert.

The NRC staff finds that the licensee has appropriately addressed the credible abnormal and accident conditions for PBAPS.

3.3.2 Boraflex Credit for the Interim Period

The licensee proposes to complete the installation of the NETCO-SNAP-IN® rack inserts by December 31, 2016. Therefore, the licensee requested partial credit of degraded Boraflex for the period of time from amendment issuance to December 31, 2016, when the installation of the NETCO-SNAP-IN® inserts will be completed ("interim period"). In Attachment 9 to the supplement dated June 21, 2012, the licensee submitted GNF report NEDC-33686P,

Revision 1, "Peach Bottom Atomic Power Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Boraflex," which provided a criticality analysis to justify regulatory compliance during the "interim period."

The licensee also proposed license conditions (shown in SE Section 3.4.3), specifying limitations on the allowable Boron-10 loss from the storage cells crediting Boraflex. The NRC staff evaluated the proposed license conditions in conjunction with the criticality analysis crediting degraded Boraflex. The licensee proposed a two-tier approach license condition for Boraflex credit during the interim period for PBAPS Unit 2 and a three-tier approach license condition for PBAPS Unit 3, as discussed below.

For PBAPS Unit 2, storage cells in spent fuel storage rack modules without NETCO-SNAP-IN® rack inserts will be placed into one of two tiers: Unrestricted or Unusable as follows:

- Unrestricted cells: Unrestricted will be cells whose minimum panel Boron-10 areal density is greater than or equal to 0.0140 grams per square centimeter (g/cm^2). Unrestricted cells may contain fuel assemblies up to a maximum in-core cold reactivity of 1.235.

- Unusable cells: Unusable will be cells whose minimum panel Boron-10 areal density is less than 0.0140 g/cm^2. Unusable cells will be administratively controlled to remain empty of any fuel assembly.

For PBAPS Unit 3, storage cells in spent fuel storage rack modules without NETCO-SNAP-IN® rack inserts will be placed into one of three tiers: Unrestricted, Restricted, or Unusable, as follows:

- Unrestricted cells: Unrestricted will be cells whose minimum panel Boron-10 areal density is greater than or equal to 0.0140 g/cm^2. Unrestricted cells may contain fuel assemblies up to a maximum in-core cold reactivity of 1.235.

- Restricted cells: Restricted will be cells whose minimum panel Boron-10 areal density is between 0.0140 g/cm^2 and 0.0112 g/cm^2. Restricted cells will only contain PBAPS Unit 3 GE14 fuel assemblies. The fuel assemblies will also have a minimum burnup of 47,400 megawatt days per metric ton. The use of Restricted cells will expire on December 31, 2013.

- Unusable cells: Unusable will be cells whose minimum panel Boron-10 areal density is less than 0.0112 g/cm^2. Unusable cells will be administratively controlled to remain empty of any fuel assembly.

The NRC staff evaluated the Boraflex criticality model with respect to unrestricted cells and restricted cells, as discussed below.

Unrestricted Cells

The Boraflex criticality analysis model is a laterally infinite model that contains the fuel lattice with standard cold core geometry (SCCG) k-infinity of 1.235 in every axial and radial location of the

fuel storage system. This approach provides conservatism by treating the lower reactivity segments of the assembly as higher in reactivity.

Boraflex panels were modeled with a Boron-10 areal density of 0.0140 g/cm^2, representing a 40% uniform loss from the estimated initial average Boron-10 areal density of 0.0235 g/cm^2, or a 33% uniform loss from the minimum certified areal density of 0.021 g/cm^2. In addition to uniform thinning, the panels are known to form gaps and cracks. The model placed a 3-inch gap centered at the mid-plane of the assembly, where neutron leakage is at minimum. The licensee stated that the maximum cumulative gap detected at PBAPS is 2.7 inches. The staff notes that 0.3 inch does not provide much margin and the staff does not agree that it will bound future gap size growth, given the uncertainties. However, the approach to co-locate the gaps and placing the consolidated gap at the most reactive axial location provides some offsetting conservatism. The analysis addressed shrinkage and edge dissolution by applying a 700 pcm reactivity bias equal to the worth of 5% reduction in panel width. The analysis also accounted for the undetected panel cracks and particle self-shielding effects by respectively applying a reactivity bias of 400 pcm and 250 pcm. These measures are appropriate to ensure that the maximum k-effective remains valid.

In addition to the Boraflex related biases discussed above, the analysis applied a 33% uncertainty, equivalent to Boron-10 areal density of 0.00465 g/cm^2, on the licensee's ability to predict the panel areal density. The Δk worth was determined to be approximately [[ ]] corresponding to the reactivity difference between the system k-effectives, assuming an areal density of [[ ]] Since this uncertainty term was statistically combined with other applicable uncertainty components, the margin allocated for this effect on the maximum k-effective is about [[ ]] pcm. The NRC staff notes that even if this uncertainty was applied as a bias, the analysis will still show that the regulatory k-effective limit of 0.95 will be met. The staff finds that the application of this additional margin supports the overall justification to partially credit Boraflex for the interim period.

The licensee also considered the following abnormal or accident conditions for the Boraflex credit analysis.

1. Dropped fuel,

2. Damaged fuel,

3. Placement of highest reactivity fuel in Boraflex credit storage cell,

4. Lack of Boraflex panels on rack periphery,

5. Misplacement of a fuel assembly,

6. Lateral movement of a rack module, and

7. Loss of SFP cooling.

Similar to the NETCO-SNAP-IN® insert analysis, the licensee accounted for these abnormal or accident conditions by [[
]] The NRC staff finds that this approach allows for a conservative determination of the maximum k-effective. The staff also finds that the licensee has identified an appropriate set of credible abnormal or accident scenarios for the Boraflex credit analysis.

In summary, the licensee's analysis for Boraflex credit provides an acceptable level margin to the regulatory k-effective limit of 0.95 at a 95% probability and 95% confidence level. The NRC staff finds reasonable assurance that the analysis, based on its assumptions and the selected uncertainties and biases, is conservative relative to the actual state of the SFP during the interim period.

Restricted Cells

A large portion of GNF report NEDC-33686P focused on the nuclear criticality safety analysis for the Unrestricted storage cells. The analysis of the Restricted storage cells consisted of determining an SCCG that would meet the k-effective requirements with the lower Boron-10 areal density. NEDC-33686P did not recalculate the biases and uncertainties for the Restricted cells, rather it used those from the Unrestricted cells to determine whether the regulatory k-effective limit of 0.95 at a 95% probability and 95% confidence level was met. While the biases and uncertainties would change, the analysis indicated there was sufficient margin to account for changes without explicit calculations.

The amount of Boraflex being credited for the Restricted cells indicates those panels would have degraded by more than 50% of uniform thinning. At approximately 45% uniform thinning degradation, the Boraflex panels are thin enough to fit two pieces side-by-side within the panel cavity. PBAPS in-situ testing of the Boraflex panels has indicated that pieces of Boraflex could drop down within the panel cavity to close pre-existing gaps/cracks. That testing did not indicate wholesale movement of Boraflex during normal operation. Therefore, the NRC staff's concern is that during a seismic event there could be wholesale movement of the Boraflex and with degradation, to the extent credited for the Restricted cells, Boraflex pieces could move past one another settling in the lower portion panel cavity. Should that occur, the top portion of the fuel would be unpoisoned and could create a critical volume.

To address the NRC staff's concerns, the licensee proposed a revised license condition for the Unit 3 Restricted cells in its letter dated April 18, 2013. The revised license condition includes a minimum burnup requirement and a time limit. While the NRC staff disagrees with the revised depletion uncertainty calculated in the April 18, 2013, letter and believes its estimation of k-effective is too low; there are several biases that the licensee did include in that estimation that could reasonably be excluded when considering the effect of a seismic event. Those are the biases for the abnormal or accident conditions described above. They can be excluded from consideration of the seismic event since they would be independent from the seismic event itself.

Therefore, the NRC staff concludes there is reasonable assurance that the PBAPS Unit 3 SFP Restricted cells would meet the regulatory k-effective limit of 0.95 at a 95% probability and 95% confidence level.

3.4 Technical Specification (TS) and License Changes

The proposed amendment would modify the TSs and the license, as discussed below.

3.4.1 Change to TS 4.3.1.1.a

The PBAPS,Units 2 and 3, TSs related to spent fuel storage are contained in TS 4.3, "Fuel Storage." TS 4.3.1, "Criticality," identifies requirements pertaining to the design of the SFP storage racks. This section currently reads as follows:

> 4.3.1 Criticality
>
> 4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:
>
> a. Fuel assemblies having a maximum k-infinity of 1.362 in the normal reactor core configuration at cold conditions;
>
> b. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 10.3 of the UFSAR; and
>
> c. A nominal 6.280 inch center to center distance between fuel assemblies placed in the storage racks.

The proposed amendment would modify TS 4.3.1.1.a to lower the allowable in-core k-infinity at cold conditions from 1.362 to 1.270.

As discussed in Section 3.2.1 of Attachment 1 to the licensee's application dated November 3, 2011, a criticality analysis was performed by the licensee to support the final SFP configuration (i.e., with the NETCO-SNAP-IN® rack inserts installed). The licensee stated that the analysis (in GNF Report NEDC-33672P) demonstrates that, for a fuel assembly with a maximum in-core k-infinity of 1.270 at cold conditions, the effective neutron multiplication factor, k_{eff}, is less than or equal to 0.95 with the following:

a) The SFP storage racks fully loaded with a GNF2 fuel design that has higher reactivity than any as-fabricated fuel in the PBAPS, Unit 2 or Unit 3 SFPs;

b) No negative reactivity credit taken for the Boraflex installed between SFP storage rack cells (Boraflex is modeled as water);

c) NETCO-SNAP-IN® rack inserts installed in all accessible and undamaged SFP storage rack cells;

d) The SFP assumed to be flooded with unborated water; and

e) Moderator temperature effects studied and appropriate reactivity biases conservatively applied in the analysis based on the results.

The NRC staff finds the proposed change to TS 4.3.1.1.a is consistent with the licensee's criticality analysis with the NETCO-SNAP-IN® rack inserts installed. Therefore, the proposed TS change is acceptable.

3.4.2 Addition of new TS 4.3.1.1.d

The proposed amendment would also add new TS 4.3.1.1.d to add a minimum Boron-10 areal density requirement of 0.0102 g/cm^2 for the NETCO-SNAP-IN® inserts. Specifically, TS 4.3.1.1.d would read as follows:

> The installed neutron absorbing rack inserts having a Boron-10 areal density $\geq$ 0.0102 g/cm^2.

As discussed in 3.3.1 of Attachment 1 of the licensee's application dated November 3, 2011:

> The insert manufacturing quality assurance testing lower limit for the areal density of boron in the Rio Tinto Alcan composite is given in terms of the isotope of Boron-10, and is 0.0105 g/cm^2. This minimum certified value used for manufacturing ensures the Boron-10 areal density value used in the criticality analysis, 0.0102 g/cm^2, is met, with some additional margin. Verification of the minimum certified areal density of Boron-10 in the rack inserts is performed during manufacturing. Verification of the areal density of Boron-10 over the lifetime of the racks will be performed through the long-term coupon surveillance program described in Section 3.9.3.

The NRC staff concludes that the proposed new requirement in TS 4.3.1.1.d, along with the Long-Term Surveillance Coupon Program, provides reasonable assurance that the minimum areal density of the the NETCO-SNAP-IN® inserts will remain within the bounds of the criticality analysis. Therefore, this proposed TS change is acceptable.

3.4.3 License Changes

In its application dated November 3, 2011, the licensee proposed a license condition (one license condition for each unit) intended to put restrictions on storage of spent fuel during the time period prior to completion of installation of the NETCO-SNAP-IN® rack inserts. In response to RAI questions from the NRC staff, the licensee revised the license conditions, as described in its letters dated November 13, 2012, and April 18, 2013. The proposed license conditions would read as follows:

Proposed License Condition 2.C(14) for Unit 2

(14) <u>Spent Fuel Pool Criticality Considerations</u>

(a) Use of spent fuel pool storage cells without NETCO-SNAP-IN® rack inserts shall be restricted as follows:

1) Minimum panel Boron-10 areal density of a storage cell shall be greater than or equal to 0.014 grams per square centimeter to store fuel assemblies with the maximum in-core cold k-infinity of up to 1.235. The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

2) A storage cell shall not contain any fuel assembly if the minimum panel Boron-10 areal density of a storage cell is less than 0.014 grams per square centimeter. The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

(b) Until the installation of NETCO-SNAP-IN® rack inserts are completed in the Peach Bottom Unit 2 spent fuel pool, Boraflex degradation shall be monitored analytically every 6 months.

(c) Boraflex degradation shall be monitored by in-situ testing in the Peach Bottom Unit 2 spent fuel pool no later than December 31, 2014, unless installation of the NETCO-SNAP-IN® rack inserts for Unit 2 have been completed prior to this date.

(d) Installation of NETCO-SNAP-IN® rack inserts shall be completed by December 31, 2016.

Proposed License Condition 2.C(14) for Unit 3

(14) <u>Spent Fuel Pool Criticality Considerations</u>

(a) Use of spent fuel pool storage cells without NETCO-SNAP-IN® rack inserts shall be restricted as follows:

1) Minimum panel Boron-10 areal density of a storage cell shall be greater than or equal to 0.014 grams per square centimeter to store fuel assemblies with the maximum in-core cold k-infinity of up to 1.235 (except as noted in a.3 below for restricted cells). The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

2) A storage cell shall not contain any fuel assembly if the minimum panel Boron-10 areal density of a storage cell is less than 0.014 grams per square centimeter (except as noted in a.3 below for restricted cells). The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

3) For the period up to December 31, 2013, cells whose minimum panel Boron-10 areal density is between 0.014 grams per square centimeter and 0.0112 grams per square centimeter may be used as restricted cells. Restricted cells will only contain Peach Bottom Unit 3 GE14 fuel assemblies with an assembly average burnup of greater than 47,400 megawatt days per metric ton. The minimum panel Boron-10 areal density shall be evaluated by assuming that the panel areal density was initially equal to a value of 0.0235 grams per square centimeter.

(b) Until the installation of NETCO-SNAP-IN® rack inserts are completed in the Peach Bottom Unit 3 spent fuel pool, Boraflex degradation shall be monitored analytically every 6 months.

(c) Boraflex degradation shall be monitored by in-situ testing in the Peach Bottom Unit 3 spent fuel pool no later than December 31, 2013, unless installation of the NETCO-SNAP-IN® rack inserts for Unit 3 have been completed prior to this date.

(d) Installation of NETCO-SNAP-IN® rack inserts shall be completed by December 31, 2016.

The NRC staff has reviewed the above license conditions and finds that they are consistent with the criticality analysis as evaluated in SE Section 3.3 and provide for monitoring of Boraflex degradation until the NETCO-SNAP-IN® rack inserts are installed. Therefore, the NRC staff concludes that the above license conditions provide reasonable assurance that the fuel storage criticality requirements, stated in GDC 62 and 10 CFR 50.68, will continue to be met.

3.5 Licensee Commitment to Revise the UFSAR

As discussed in Attachment 11 of the licensee's application dated November 3, 2011, the licensee committed to revise the PBAPS UFSAR to add a description of the Rack Insert Surveillance Program, described in Section 3.9 of Attachment 1 of the application, as part of the implementation of the proposed amendment. The Rack Insert Surveillance Program includes three surveillance programs as follows: the Fast Start Coupon Surveillance Program, the Long-Term Coupon Surveillance Program, and the Full Rack Insert Surveillance Inspection Program.

As discussed in Section 4.4.1 of the NRC's Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-101, Revision 4, "License Amendment Review Procedures" (ADAMS Accession No. ML113200053), since commitments made by a licensee in support of a license amendment request are not legally binding, the staff's SE should not rely on commitments as a basis for any

part of the staff's approval of a proposed amendment. However, the staff may rely on a commitment if it is escalated into an obligation (e.g., license condition) or subsequently incorporated into a mandated licensing basis document (e.g., UFSAR). As discussed in SE Sections 3.1, 3.2 and 3.4, the NRC staff has relied on the programs within the Rack Insert Surveillance Program as part of the staff's acceptance of the proposed amendment. Consistent with the guidance in NRR Office Instruction LIC-101, the staff has determined that the commitment should be incorporated into the UFSAR. As such, the NRC staff, has added the following words as a condition of the amendment to ensure that the UFSAR is revised as part of the amendment implementation:

> Implementation of the amendment shall include revision of the Updated Final Safety Analysis Report as described in Attachment 11 to the licensee's letter dated November 3, 2011.

The NRC staff notes that, following incorporation of the Rack Insert Surveillance Program into the UFSAR, future changes to the program will be under the provisions of 10 CFR 50.59.

3.6 Technical Evaluation Conclusion

Based on the discussion in SE Sections 3.1 through 3.5, the NRC staff concludes that the proposed amendment is acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Pennsylvania State official was notified of the proposed issuance of the amendments. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (77 FR 33247). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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Date: May 21, 2013

The NRC staff has determined that its safety evaluation (SE) for the subject amendments contains proprietary information pursuant to Title 10 of the *Code of Federal Regulations,* Section 2.390. Accordingly, the NRC staff has prepared a redacted, publicly available, non-proprietary version of the SE. Both versions of the SE are enclosed. Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/ra/

Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-277 and 50-278

Enclosures:
1. Amendment No. 287 to Renewed DPR-44
2. Amendment No. 290 to Renewed DPR-56
3. Non-Proprietary SE
4. Proprietary SE

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Cover letter and Enclosures 1, 2, and 3: ML13114A929
Enclosure 4 (Proprietary SE): ML13122A423 *via email

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