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PROPRIETARY INFORMATION – WITHHOLD UNDER 10 CFR 2.390

10 CFR 50.90

RS-13-148
July 16, 2013

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

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: License Amendment Request – Use of Neutron Absorbing Inserts in Units 1 and 2 Spent Fuel Pool Storage Racks

In accordance with 10 CFR 50.90, Exelon Generation Company, LLC (EGC) requests a proposed change to modify the Technical Specifications (TS) to include the use of neutron absorbing spent fuel pool rack inserts (i.e., NETCO-SNAP-IN® rack inserts) for the purpose of criticality control in the spent fuel pools (SFPs) at Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. This change is being requested due to degradation of the Boraflex neutron absorbing material, currently being used in the QCNPS SFPs.

Installation of the rack inserts began in the Unit 1 spent fuel pool in mid-2012 under the provisions of 10 CFR 50.59. The installation schedule has been accelerated such that all rack inserts in both the Unit 1 and Unit 2 spent fuel pools are projected to be installed by December 31, 2014. Criticality control using the NETCO-SNAP-IN® rack inserts will not be credited until and unless a license amendment is granted in response to this request.

EGC requests approval of the proposed amendment by December 31, 2014, which coincides with the targeted completion date of the rack insert installation. Once approved, the amendment will be implemented within 30 days.

The following attachments are included in support of this proposed change:

Attachment 1: Evaluation of Proposed Changes
Attachment 2: Markup of Technical Specifications Page (Note that there are no TS Bases associated with the Design Features section of the TS)
Attachment 3a: Figure of a Typical NETCO-SNAP-IN® Rack Insert – Style 1
Attachment 3b: Figure of a Typical NETCO-SNAP-IN® Rack Insert – Style 2
Attachment 4: Holtec International Report No. HI-2125245, Revision 2, "Licensing Report for Quad Cities Criticality Analysis for Inserts" (Proprietary Version)

Attachments 4 and 6 transmitted herewith contain Proprietary Information.
When separated from attachments, this document is decontrolled.

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Attachment 5:	Holtec International Report No. HI-2125245, Revision 2, "Licensing Report for Quad Cities Criticality Analysis for Inserts – Non Proprietary Version"
Attachment 6	Holtec International Report No. HI-2104790, Revision 1, "Nuclear Group Computer Code Benchmark Calculations" (Proprietary)
Attachment 7:	Holtec International Affidavit Requesting Proprietary Reports be Withheld from Public Disclosure, Document ID 2127005
Attachment 8:	NETCO Report NET-259-03, Revision 5, "Material Qualification of Alcan Composite for Spent Fuel Storage"
Attachment 9:	Summary of Regulatory Commitments
Attachment 10	NETCO Report NET-332-01, Revision 1, "Inspection and Testing of BORAL® and Fast Start Surveillance Coupons from the LaSalle County Units 1 & 2 Stations"
Attachment 11	NETCO Report NET-300054-01, Revision 0, "Inspection and Testing of Fast Start Surveillance Coupons F22-F11 from the LaSalle County Unit 2 Station"

Attachments 4 and 6 contain information proprietary to Holtec International. As Attachments 4 and 6 contain information proprietary to Holtec International, they are supported by an affidavit (i.e., Attachment 7) signed by Holtec International, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.390, "Public inspections, exemptions, requests for withholding." Accordingly, it is respectfully requested that the information which is proprietary to Holtec International be withheld from public disclosure. A non-proprietary version of Attachment 4 is provided in Attachment 5. Holtec International Report, HI-2104790 (i.e., Attachment 6), is considered proprietary in its entirety and; therefore, has no non-proprietary version.

Correspondence with respect to the proprietary aspects of the items listed above or the supporting Holtec International affidavit should reference Document ID 2127005 and should be addressed to Debabrata (Debu) Mitra-Majumdar, Ph.D., Corporate Director – Engineering Analysis, Holtec International, Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053.

The proposed changes have been reviewed by the QCNPS Plant Operations Review Committee, and approved by the Nuclear Safety Review Board in accordance with the requirements of the EGC Quality Assurance Program.

In accordance with 10 CFR 50.91, EGC is notifying the State of Illinois of this application for license amendment by transmitting a copy of this letter and its attachments to the designated State Official.

As noted above, a summary of the regulatory commitments contained in this submittal is provided in Attachment 9.

Should you have any questions concerning this letter, please contact Ken Nicely at (630) 657-2803.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 16th of July 2013.

Respectfully,

David M. Gullott
Manager – Licensing
Exelon Generation Company, LLC

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cc: USNRC Region III, Regional Administrator
USNRC Senior Resident Inspector, QCNPS
Illinois Emergency Management Agency – Division of Nuclear Safety

Attachment 1
Evaluation of Proposed Changes

1.0 SUMMARY DESCRIPTION

In accordance with 10 CFR 50.90, "Application for amendment of license, construction permit, or early site permit," Exelon Generation Company, LLC (EGC) requests an amendment to Renewed Facility Operating License Nos. DPR-29 and DPR-30 for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The proposed change allows the use of NETCO-SNAP-IN® neutron absorbing rack inserts in the storage rack cells in the Unit 1 and Unit 2 spent fuel pools (SFPs). This change is being requested due to degradation of the Boraflex neutron absorbing material, currently being used in the QCNPS SFPs.

2.0 DETAILED DESCRIPTION

The proposed change requests NRC approval for use of an alternate mechanism other than Boraflex neutron absorber panels for criticality control in the SFP as Boraflex has experienced degradation of its neutron absorbing capability. This application requests approval to use a neutron absorbing rack insert that can be installed into a SFP storage rack cell and credited as a replacement for the neutron absorbing properties of the Boraflex panels. EGC is requesting this license amendment to use NETCO-SNAP-IN® rack inserts to provide an alternative method of ensuring neutron absorption in the Unit 1 and Unit 2 SFP storage racks to meet the effective neutron multiplication factor, k_{eff}, criticality control requirement without reliance on Boraflex. This license amendment request (LAR) is modeled after the LARs for LaSalle County Station (LSCS), Units 1 and 2; and Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3 (as it relates to the final SFP configuration with NETCO-SNAP-IN® rack inserts installed and credited). Both of these LARs have been approved by the NRC (i.e., LaSalle County Station, Units 1 and 2, Issuance of Amendments Concerning Spent Fuel Neutron Absorbers (TAC Nos. ME2376 and ME2377), dated January 28, 2011, (Accession No. ML110250051); and 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), dated May 21, 2013 (Accession No. ML13114A929)).

Fabrication of the NETCO-SNAP-IN® rack inserts began in 2012. Installation of the inserts in all useable and accessible SFP storage rack cells (i.e., cells with no obstructions or damage preventing a rack insert from being placed in the cell) began in mid-2012 under the provisions of 10 CFR 50.59. Installation of NETCO-SNAP-IN® rack inserts in all useable and accessible spent fuel storage pool rack cells in both QCNPS units is projected to be complete by December 31, 2014.

Upon installation of the inserts in all useable and accessible SFP rack cells, reliance on Boraflex as a neutron poison material will no longer be required; however, the NETCO-SNAP-IN® rack inserts will not be credited for criticality control until and unless NRC approval of the proposed changes is obtained. Based on the projected insert installation completion date, EGC is requesting NRC approval of the proposed license amendment by December 31, 2014. Once approved, the amendment will be implemented within 30 days.

2.1 Proposed Changes to Technical Specifications

The QCNPS, Units 1 and 2 Technical Specifications (TS) requirements related to spent fuel storage are contained in TS Section 4.3, "Fuel Storage." TS 4.3.1 identifies requirements pertaining to the design of the SFP storage racks. Specifically, TS 4.3.1.1.a currently requires k_{eff} to be $\leq$ 0.95 if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1.2 of the Updated Final Safety Analysis Report (UFSAR). TS 4.3.1.1.b currently requires a nominal 6.22-inch center-to-center distance between fuel assemblies placed in the SFP storage racks.

No substantive changes to the existing TS 4.3.1.1.a or 4.3.1.1.b are proposed in this license amendment request. The proposed changes in this license amendment request include two new TS requirements, 4.3.1.1.c and 4.3.1.1.d. Those proposed changes are as follows:

c. *The combination of U-235 enrichment and gadolinia loading shall be limited to ensure fuel assemblies have a maximum k-infinity of 0.9131 as determined at 4°C (39.2°F) in the normal spent fuel pool in-rack configuration; and*

d. *The installed neutron absorbing rack inserts having a Boron-10 areal density $\geq$ 0.0116 g/cm^2.*

A markup of the proposed TS changes is provided in Attachment 2. The UFSAR will also be revised, upon implementation of the approved amendment, as part of EGC's configuration control process.

The current QCNPS TS were based on the Standard TS for General Electric BWR/4s in NUREG-1433, "Standard Technical Specifications General Electric Plants, BWR/4," Revision 1, April 1995, with exceptions as approved during the QCNPS, Units 1 and 2 TS conversion (i.e., see NRC Safety Evaluation Report dated March 30, 2001). NUREG-1433, Revision 1 (and the most recent revision; i.e., Revision 4) provide an option to include either the maximum k-infinity in the normal reactor core configuration at cold conditions; or the maximum average U-235 enrichment as part of TS 4.3.1.1. Neither of these options is included in these proposed TS changes as this exception was approved during the QCNPS TS conversion referenced above. An in-rack k-infinity limit is included in proposed TS 4.3.1.1.c for QCNPS, Units 1 and 2 in this amendment request. The enrichment and in-rack k-infinity limitations, each individually, provide adequate protection to ensure public health and safety in that they determine the reactivity limit for the fuel assemblies that are allowed to be stored in the SFP storage racks.

The in-rack k-infinity limit is an effective limiting specification because it accounts for the principal fuel assembly reactivity drivers of U-235 enrichment and gadolinia loading. Enrichment and gadolinia loading can vary from assembly design to assembly design. However, compliance with the in-rack k-infinity limit in proposed TS 4.3.1.1.c ensures peak in-rack reactivity does not exceed the design basis supporting the TS limit. Using the in-rack k-infinity limit ensures that the SFP criticality analysis remains bounding. This is the same protection offered by the in-core k-infinity limit proposed in the Standard Technical Specifications.

3.0 TECHNICAL EVALUATION

3.1 Background and Approach

As noted above, degradation of the Boraflex material, currently in use at the QCNPS SFP, is prompting the need for this license amendment request. The following discussion will show that NETCO-SNAP-IN® rack inserts are a safe and effective replacement for the degrading Boraflex panels to ensure continued compliance with TS requirements.

This evaluation will first provide information on the current SFP design and present the proposed approach to resolve Boraflex degradation in the following sections:

Subsequent to this information, evaluation of key technical issues associated with the NETCO-SNAP-IN® rack inserts will be discussed in the following sections:

Finally, the rack insert surveillance program, and installation and removal of rack inserts will be discussed in the following sections:

3.1.1 Current Spent Fuel Pool Design Basis

QCNPS UFSAR Section 9.1.2 documents the QCNPS, Units 1 and 2 SFP safety design bases as summarized below. The similarity of the SFP storage rack designs for the two units permit a single set of supporting analyses to apply to both units.

a. The spent fuel assembly racks are designed to ensure subcriticality in the storage pool. A maximum k_{eff} of 0.95 is maintained with the racks fully loaded with fuel of the highest anticipated reactivity and flooded with unborated water at a temperature corresponding to the highest reactivity.

b. The spent fuel storage pools have been designed to withstand the anticipated earthquake loadings as a Class I structure.

c. The high-density racks are engineered to achieve the dual objective of maximum protection against structural loading (such as ground motion) and the maximization of available storage locations.

The QCNPS Unit 1 SFP is designed for 19 high-density fuel racks in nine different module sizes. The module types are labeled A through K in UFSAR Figure 9.1-12, which also shows their relative placement. There are a total of 3,657 designed storage locations in the QCNPS Unit 1 pool.

The QCNPS Unit 2 SFP is designed for 20 high-density fuel racks in nine different module sizes. The module types are labeled A through K in UFSAR Figure 9.1-13, which also shows their relative placement. There are a total of 3,897 designed storage locations in the QCNPS Unit 2 pool.

QCNPS UFSAR Table 9.1-1 provides the quantity, number of fuel cells (i.e., rack cells) per rack module, and the array size of each rack module type, A through K.

The high density SFP storage rack modules are a modular honeycomb arrangement of storage cells. The storage cells are constructed of a series of cruciform-shaped neutron absorbing elements to form a modular rack as shown in QCNPS UFSAR Figures 9.1-7 through 9.1-9. Each fuel cell accommodates a single Boiling Water Reactor (BWR) fuel assembly and flow channel.

Sheets of Boraflex neutron absorbing material are sandwiched between the 304 stainless steel walls of the adjacent storage cells. The two Boraflex sheets and nominal three-inch water flux trap between the outer absorber sheets of adjacent modules effectively isolate the individual modules from each other.

Each rack module assembly is supported on four plate-type supports (see UFSAR Figure 9.1-10). The supports elevate the rack module baseplate 6.5 inches above the pool floor level, thus creating a water plenum for cooling water flow (see UFSAR Figures 9.1-10 and 9.1-11). The spent fuel rack modules are not anchored to the pool floor or connected to the pool walls. The nominal center-to-center spacing of the fuel bundles in the racks is 6.22 x 6.22 inches (see UFSAR Figure 9.1-9).

3.1.2 Boraflex Degradation

Boraflex is currently in use in the QCNPS, Units 1 and 2 SFPs and is credited in the current licensing basis criticality analysis for the wet storage racks. NRC Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks," documents a concern with the Boraflex neutron absorbing material used in SFPs. Specifically, when Boraflex is subjected to gamma radiation in a SFP environment, the silicon polymer matrix becomes degraded and silica filler, boron carbide, and soluble silica are released. The degradation of Boraflex in the QCNPS

SFPs has reduced its ability to perform its neutron absorption design function. The Boraflex degradation is continuing; thus prompting the need for this amendment request.

A Boraflex monitoring program, comprised of BADGER testing and RACKLIFE analyses, was instituted as a License Renewal Program commitment. Upon approval of the requested changes, this monitoring program will no longer be needed and will subsequently be discontinued.

3.1.3 NETCO-SNAP-IN® Rack Inserts Design Description

This proposed change would credit NETCO-SNAP-IN® rack inserts for criticality control in individual SFP storage rack cells to ensure that the requirements of TS 4.3.1, "Criticality," are maintained; specifically, "The spent fuel storage racks are designed and shall be maintained with $k_{eff} \leq 0.95$ if fully flooded with unborated water..." Note that the installation of the NETCO-SNAP-IN® rack inserts is being controlled as a design change implemented under the provisions of 10 CFR 50.59 from a structural, seismic, and thermal-hydraulic perspective.

The rack insert is made entirely of the Rio-Tinto Alcan composite neutron absorbing material which contains boron carbide (B_4C) particles homogeneously distributed in the metal. The rack insert encompasses the full length of the active fuel region of the fuel assembly when installed in the storage rack cell. The rack inserts are nominally the same length as a rack cell (approximately 165 inches).

An insert design was developed to fit the nominal QCNPS SFP rack cell. The original rack insert design (i.e., Style 1) was modified to address fit and installation issues encountered during installation. Minor dimensional changes were incorporated into Style 2 (e.g., nominal wing width, insert length, etc.) and analysis/testing was performed to validate performance relative to critical parameters (e.g., areal density, reactivity worth, retention force, etc.).

While the rack modules are arranged differently in the two SFPs, the individual rack cells are of the same nominal dimensions. Thus, either style of NETCO-SNAP-IN® rack insert could be installed in any rack cell, barring minor fit issues, as the critical parameters (noted above) have been validated for both insert styles. Note that as the insert installation campaign continues, minor dimensional alterations to the current styles of inserts may be made, as necessary, to accommodate fit or installation issues for specific SFP storage cells. Should any additional styles of inserts be used, the critical parameters (e.g., areal density, reactivity worth, retention force, etc.) will be validated.

The NETCO-SNAP-IN® inserts are formed with a greater than 90-degree bend angle. This requires compression of the rack insert to install it into the SFP storage rack cell. After installation, the insert will conform to the 90-degree angle between adjacent spent fuel storage rack cell walls. When installed, the rack insert wings abut against the two adjacent faces of the SFP storage rack cell wall.

The QCNPS inserts are slightly thicker than the inserts used at the LSCS and PBAPS, and have a boron content of 17 volume percent B_4C. The dimensions of the QCNPS inserts are also slightly different because they are specifically designed to fit into the QCNPS SFP storage racks. See Table 3.3-1 for a comparison of the dimensional and physical properties of the NETCO-SNAP-IN® rack inserts being used at LSCS, PBAPS and QCNPS.

Near the top of the NETCO-SNAP-IN® rack insert is a hole in each wing that engages the installation tool (see Attachments 3a and 3b). The rack insert is designed to become an integral part of the spent fuel storage rack once it has been installed. This is achieved through the inherent design characteristics of the inserts relative to the SFP storage racks. The design and fabrication of the inserts result in a tight fit which causes deformation of the insert. The force exerted due to this deformation is determined by the material properties of the rack insert. The force between the wings of the rack insert and the spent fuel storage rack cell walls in conjunction with the static friction between these surfaces serves to retain the NETCO-SNAP-IN® rack insert and make it an integral part of the SFP storage rack once it is installed.

A criticality analysis for the QCNPS, Units 1 and 2 SFPs crediting the NETCO-SNAP-IN® rack inserts has been performed to support this design change. A summary of that analysis is provided as Attachment 4. The criticality analysis was performed using a peak reactivity lattice. This peak reactivity lattice bounds the lattice for any fuel assembly stored in either the Unit 1 or Unit 2 SFP and operating in either the Unit 1 or Unit 2 reactor, to assure compliance with the spent fuel criticality control requirements in 10 CFR 50.68(b) and Interim Staff Guidance (ISG) DSS-ISG-2010-01 (Reference 5).

The analysis demonstrates that k_{eff} remains less than or equal to 0.95 for the normal, abnormal, and accident cases evaluated, crediting the NETCO-SNAP-IN® rack inserts for criticality control with no soluble boron in the SFP water. It is important to note that the Boraflex panels will remain in place in the SFP storage rack cells, which will provide additional neutron absorption capability that is not credited in the rack insert criticality analysis. Water is modeled in the criticality analysis in spaces where the Boraflex panels are located.

It is also known that certain SFP storage rack cells will not be able to accept the insertion of either the NETCO-SNAP-IN® rack insert or spent fuel, or both, due to rack damage or inaccessibility caused by a physical interference. SFP storage rack cells that do not contain a rack insert will be declared inoperable for storage of nuclear fuel. The misloading of a peak reactivity fuel assembly into a cell location without an insert is analyzed as an accident condition in the criticality analysis (see Attachment 4, Section 2.6.5).

3.1.4 Demonstration of Proposed Method for Rack Insert Installation

The overall objective of the QCNPS insert demonstration program was to verify the design and operational characteristics of the NETCO SNAP- IN® for use in the QCNPS SFP. The NETCO-SNAP-IN® rack inserts used in the QCNPS demonstration program were designed, fabricated, tested, and inspected under the NETCO quality assurance program to ensure they meet the design requirements for the permanent inserts.

The mechanical feasibility of using NETCO SNAP-IN® rack inserts at QCNPS has been verified by two phases of the demonstration program. Phase 1 installed two rack inserts of Style 1 into the QCNPS Unit 2 SFP storage rack cells. Each insert underwent interference testing using a channeled bundle and retention load testing using the removal tool. Phase 1 testing in the Unit 2 pool is representative of inserts in the Unit 1 pool because the rack designs are the same.

During the subsequent insert installation campaign, the initial rack insert design (i.e., Style 1) experienced fit issues necessitating minor dimensional changes (i.e., Style 2). Three variations of Style 2 inserts, varying only in wing width, were tested as part of the second testing campaign (i.e., Phase 2). Phase 2 testing repeated the Phase 1 testing scope (with the exception that "interference" testing was conducted to identify any interference while installing an insert but did not record a "drag force" value) to determine the best fit for ease of installation. A single Style 2 design was selected for continued manufacturing. This selected design of Style 2 was more extensively tested with a similar scope as Phase 1 using a larger quantity of inserts and selecting various cells in different racks.

Style 1 inserts successfully installed during the initial installation campaign remain in the SFP. Style 2 inserts, successfully installed during Phase 2 testing and the subsequent installation campaign, remain in the SFP. As noted above, should any additional styles of inserts be used due to SFP storage cell fit or installation issues, the critical insert parameters (e.g., areal density, reactivity worth, retention force, etc.) will be validated.

In summary, the key insert parameters validated during the demonstration program were: 1) insertion success; 2) lack of fuel interference; and 3) retention force (i.e., greater than 100 lbf). These parameters are discussed in further detail in Section 3.4.3, "Insertion, Drag and Retention Forces," below.

3.1.5 Installation Schedule

The rack inserts installation began in mid-2012 and is projected to be completed in both units by December 31, 2014.

3.2 Criticality

3.2.1 Criticality Evaluation for NETCO Rack Insert Spent Fuel Pool Configuration

A criticality safety analysis was performed to support the storage of spent fuel in the QCNPS, Units 1 and 2 SFPs in various configurations with the NETCO-SNAP-IN® rack inserts installed. The analysis (summarized in Attachment 4) demonstrates that, for a fuel assembly with a maximum in-rack k-infinity of 0.9131 and a minimum insert Boron-10 (B-10) areal density of 0.0116 g/cm^2, the effective neutron multiplication factor, k_{eff}, is less than or equal to 0.95 with:

1. The SFP storage racks fully loaded with a fuel design that bounds any fuel in the QCNPS, Unit 1 or Unit 2 SFPs;

2. No negative reactivity credit taken for the Boraflex installed between SFP storage rack cells (i.e., Boraflex is conservatively modeled as water);

3. NETCO-SNAP-IN® rack inserts installed in all useable and accessible SFP storage rack cells;

4. The SFP assumed to be flooded with unborated water; and

5. The most limiting moderator temperature condition (i.e., 39.2 °F or 4 °C) used in the analysis.

The bounding fuel assembly, as determined by the analysis summarized in Attachment 4, is the Westinghouse Optima 2 fuel design. The determination of the bounding fuel assembly design is based on detailed sensitivity studies performed for all fuel types currently onsite at QCNPS. The details of these sensitivity studies are included in Attachment 4.

The reactivity of the QCNPS, Units 1 and 2 SFP storage racks containing NETCO-SNAP-IN® rack inserts has been calculated using the computer codes CASMO-4 and MCNP5 (see Attachment 4). CASMO-4 was used to determine the exposure-dependent pin-by-pin isotopic fuel compositions utilizing the ENDF/B-V cross-section data library. The potential future Measurement Uncertainty Recapture (MUR) power uprate and other depletion variations as described in Table 5.2(a) of Attachment 4 were considered in the core depletion parameters. CASMO-4 has been accepted for use in reactor depletion analyses. MCNP5 was used with the CASMO-4 pin-specific isotopic fuel compositions and the ENDF/B-VII cross-section data to compute peak in-rack reactivity. MCNP5 has been validated and verified for SFP storage rack evaluations by benchmarking calculations of light water reactor (LWR) critical experiments as discussed in Attachment 4, Section 2.2 Computer Codes and Cross Section Libraries, Subsection, 2.2.1, "MCNP5-1.51." The benchmarking report for the MCNP5-1.51 code, which is a three-dimensional Monte Carlo code, is included in Attachment 6, Holtec International Report No. HI-2104790, Revision 1, "Nuclear Group Computer Code Benchmark Calculations."

The NRC has previously approved the use of the CASMO-4 code (see Reference 6) for reactor analysis (i.e., depletion) when providing reactivity data for specific 3D simulator codes as noted in Attachment 4, Section 2.2.2, "CASMO-4." Interim Staff Guidance (ISG) DSS-ISG-2010-01 (Reference 5) was also used when performing the criticality analysis. See Table 3.2-1 for a cross-reference table that identifies the specific location in the criticality licensing report where each ISG topic is addressed.

3.2.2 Interim Staff Guidance DSS-ISG-2010-01

NRC Interim Staff Guidance (ISG) DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," Revision 0, was reviewed and addressed, as applicable, in the criticality analyses. Guidance pertaining to soluble boron in the SFP is not applicable because QCNPS is a BWR plant and has no soluble boron in the SFP. Table 3.2-1 below provides a cross-reference between the ISG technical guidance topic and the location where this topic is addressed in the criticality analysis.

Table 3.2-1
NRC ISG-DSS-2010-01 Cross-Reference to Criticality Analyses

ISG SECTION	TECHNICAL GUIDANCE TOPIC	NETCO INSERT ANALYSIS SECTION (Attachment 4)
1	Fuel Assembly Selection	2.3.1 5.1 Appendix A
2 - Depletion Analysis		
2.a	Depletion Uncertainty	2.3.3
2.b	Reactor Parameters	2.3.1.5 5.2 Table 5.2(a)
2.c	Burnable Absorbers	2.3.1.1 2.3.1.5.2
2.d	Rodded Operation	2.3.1.5 Table 5.2(b) Table 5.2(c)

ISG SECTION	TECHNICAL GUIDANCE TOPIC	NETCO INSERT ANALYSIS SECTION (Attachment 4)
3 - Criticality Analysis		
3.a	Axial Burnup Profile	2.3.1
3.b	Rack Model	5.4 Table 5.3(a) Table 5.3(b)
3.c	Interfaces	2.8
3.d	Normal Conditions	2.3.5.2 2.3.5.4 2.3.6 2.5 2.9 Table 5.2(a)
3.e	Accident Conditions	2.6
4 - Criticality Code Validation		
4.a	Area of Applicability	Table 2.1(a)
4.b	Trend Analysis	2.2.1.1 Table 2.1(b)
4.c	Statistical Treatment	2.2.1.1
4.d	Lumped Fission Products	2.2.1.1.1
4.e	Code-to-Code Comparisons	N/A[1]
5 - Miscellaneous		
5.a	Precedents	N/A[2]
5.b	References	Throughout
5.c	Assumptions	Throughout

NOTES: 1. Not used in this analysis.
2. This analysis is a complete, stand-alone analysis and does not cite any precedents.

3.3 Materials

The NETCO-SNAP-IN® Rio-Tinto Alcan composite rack insert material must ensure that the neutron absorber remains in place over the lifetime of the SFP storage racks during normal operation and abnormal events. Attachment 8 provides a detailed evaluation of the Rio-Tinto Alcan composite material. This report demonstrates that the material is suitable as a neutron absorber to maintain the SFPs within design and regulatory limits over the life of the SFP storage racks. Qualification testing has been performed to confirm its acceptability and the surveillance programs described in Section 3.9 will be established to confirm its continued acceptability to perform its required design functions in the QCNPS SFPs.

The production process for manufacturing the rack inserts is described in detail in Attachment 8. The rack insert is made from one sheet of composite material. Rio-Tinto Alcan developed a technique to produce a homogeneous distribution of B_4C in the finished product.

Coupons will be cut from each rolled rack insert blank which is of sufficient size to manufacture two rack inserts. Samples from the coupons are subjected to: 1) neutron attenuation testing to verify the as-manufactured Boron-10 areal density; 2) ICP (Inductively Coupled Plasma) Analysis to verify material composition; and 3) tensile testing to verify mechanical properties.

3.3.1 Areal Density of Boron-10

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 B-10, and is 0.0116 g/cm^2. Verification of the minimum certified areal density of B-10 in the rack inserts is performed during manufacturing. Verification of the areal density of B-10 over the lifetime of the racks will be performed through the long-term coupon surveillance program described in Section 3.9.3 below.

The measurement uncertainty of the neutron attenuation testing is taken into account, at a 95 percent confidence level, when determining the acceptability of a given test result. Individual tested coupons must meet or exceed the 0.0116 g/cm^2 Boron-10 limit with this uncertainty subtracted from the measured value. Additionally, an analysis is performed on the coupon population's areal density to ensure that the 95/95 limit of the production batch exceeds the minimum specified areal density value of 0.0116 g/cm^2.

Note that Attachment 8, Section 3.4 refers to a B-10 areal density limit of 0.0087 g/cm^2 for the Quality Assurance test program. This value is for the NETCO-SNAP-IN® rack inserts manufactured for LSCS. All of the NETCO-SNAP-IN® rack inserts manufactured for a particular user have the same minimum required B-10 areal density, but that value may be different user-to-user. The 0.0087 g/cm^2 is an example value used in the NETCO material qualification report and is not indicative of the minimum required B-10 areal density in all NETCO-SNAP-IN® rack inserts for all customers. The B-10 areal density in the inserts for a given plant is customized for each user's needs based on the criticality analysis and rack design. Each user specifies the minimum required B-10 areal density for their plant's inserts in the procurement specification, specifically, the value used in the criticality analysis. For QCNPS, the minimum required manufactured B-10 areal density value is 0.0116 g/cm^2.

3.3.2 Corrosion

Resistance to material loss, pitting, cracking, and blistering is important to ensuring that the B-10 will not be lost, and that distortion of the rack insert will not interfere with future fuel movement. Therefore, an accelerated corrosion test program was performed to determine the susceptibility of the Rio-Tinto Alcan composite to general (i.e., uniform) and localized (i.e., pitting) corrosion in BWR SFPs. This program is described in detail in Attachment 8. The material qualification program included material at 16 volume percent and 25 volume percent loadings of boron carbide. The range of as-tested boron carbide loadings of the test coupons bound the loading to be used at QCNPS (17 volume percent B_4C). Three types of coupons were tested: (1) rectangular general coupons, to determine the rate at which a uniform oxide film forms; (2) bend coupons, intended to simulate the bent section of the NETCO-SNAP-IN® rack insert, to determine whether or not bend deformation and stress adversely affect the corrosion susceptibility of the Rio-Tinto Alcan material; and (3) galvanic (i.e., bi-metallic) coupons, prepared with the Rio-Tinto Alcan composite and 304L stainless steel, Inconel 718, and Zircaloy materials to evaluate the potential for galvanic corrosion. Coupons have been tested at the NETCO laboratory in deionized water, simulating BWR pool conditions at 195°F (90.5°C) for greater than 8,000 hours to accelerate any corrosion effects. Coupons were removed after approximately 2,000, 4,000, 6,000, and 8,000 hours and subjected to testing. This test program has been completed and the evaluation is presented in Attachment 8, Table 5-7.

Prior to testing, the coupons were pre-characterized with respect to thickness, weight, and B-10 areal density. After testing, the coupons were subjected to post-test characterization of these same attributes. The testing results are described in Attachment 8. Measured corrosion rates were very low. The reason for the low corrosion rates is that the oxide film is largely self-passivating, limiting the rate of subsequent oxidation of the base metal. This property of the oxide film lends to the excellent corrosion resistance of AA1100 aluminum alloy. It is noted that the conversion of a thin, uniform layer to the oxide does not result in a loss of the boron carbide neutron absorber. This is confirmed by the neutron attenuation measurement results that show no change in B-10 areal density.

Optical microscopy was performed to verify that the oxide films were substantially removed prior to determining coupon weight loss and prior to inspecting for any anomalies along the outer bend radii of the bend coupons. Optical microscopy of the inside and outside radius of the bend coupons before and after acid cleaning revealed no cracks or other anomalistic corrosion behavior.

Once installed, the NETCO-SNAP-IN® rack inserts assume a constant strain condition within the SFP storage rack cell. This compression leads to internal stresses, especially at the bend, that might make the rack inserts susceptible to stress corrosion cracking. An examination of the literature on the subject (i.e., References 1 and 2) indicates that, in general, high-purity aluminum and low-strength aluminum alloys are not susceptible to stress corrosion cracking. However, surveillance bend coupons to be placed in the SFP will be maintained under the same strain conditions to provide indication of any unexpected crack phenomena.

3.3.3 NETCO-SNAP-IN® Rack Insert Dimensions and Physical Properties

The NETCO-SNAP-IN® rack inserts to be used in the QCNPS spent fuel storage pools are dimensionally and physically similar to those being used at LaSalle County Station (LSCS) and Peach Bottom Atomic Power Station (PBAPS) as shown in Table 3.3-1.

Table 3.3-1
Insert Dimensions and Physical Properties for QCNPS, LSCS, and PBAPS

DIMENSION OR PROPERTY	QCNPS VALUE	LSCS VALUE	PBAPS VALUE
Length (in.)	Style 1: 165.25 Style 2: 165.00	167.75	169
Thickness (in.)	0.085	0.065	0.075
B-10 Minimum Manufactured Areal Density (g/cm^2)	0.0116	0.0087	0.0105
B_4C Density (vol %)	17	17	19

3.4 Mechanical

3.4.1 Fuel Assembly Clearances

Placement of the rack inserts in a SFP storage rack cell slightly reduces the cell inside dimensions available for fuel assembly insertion. The insert demonstration program confirmed adequate clearance between a fuel assembly and rack cells containing inserts by inserting and removing a dummy fuel bundle that is dimensionally the same as a channeled fuel assembly.

If there is unexpected warping or bowing of the rack insert after installation that reduces the fuel assembly-to-spent fuel storage rack insert clearance, then the fuel handler would notice increased force indicated on the hoist load cell when attempting to raise (i.e., remove) an assembly. If the rack insert would inadvertently come out of a spent fuel storage rack cell with an assembly, this condition is bounded by the missing rack insert evaluation in the criticality analysis (see Section 2.6.5 of Attachment 4).

If a channeled spent fuel assembly cannot fit into the Unit 1 or Unit 2 spent fuel storage rack cells containing rack inserts due to mechanical clearances, the fuel assembly will be de-channeled and stored.

3.4.2 Mechanical Wear

Minimal insert material wear is expected within the active fuel region due to adequate clearance between the fuel assembly and rack insert. The combined effects of adequate clearance and infrequent fuel assembly movement will preclude significant wear of the rack insert. A rack insert in a high-duty rack cell location (i.e., one with a relatively high number of fuel assembly insertions and removals) will be inspected for wear as described below in Section 3.9.4.2, "Insert Removal for Inspection."

Manufacturing experience with the inserts has shown that handling and environmental damage may lead to scratches and surface imperfections locally along the insert length. Local effects have been accounted for in the criticality analysis by conservatively assuming that an entire insert is missing from a cell. Because the clearance between the fuel and insert has been verified by a channeled fuel assembly, it is unlikely that a significant number of those events would result in any contact leading to uniform degradation of the insert face.

3.4.3 Insertion, Drag and Retention Forces

<u>Clean Pool Testing (NETCO Facility)</u>

Insertion, drag and retention force testing of the rack inserts was performed in a clean pool environment in February 2012. These clean pool tests were performed at the NETCO facility using specially made, full scale test cells that were fabricated using design specifications of the SFP rack cells at QCNPS. During these tests, full size NETCO-SNAP-IN® inserts, made from the same Rio-Tinto Alcan W1100N series material that will be used in the QCNPS SFPs, were installed and removed from each test cell in order to verify that the mechanical design specifications for each NETCO-SNAP-IN® insert size had been met.

The clean pool testing verified specific design criteria which included the insertion forces required to install the inserts, drag forces which measured any fuel interference, and retention force testing to establish the force with which the inserts were held in place. This clean pool testing verified the mechanical design criteria and assumptions in a clean pool environment, and demonstrated with reasonable assurance that the installation, drag (fuel interference) and retention forces imposed on these inserts will not induce a condition that would prevent the inserts from performing their intended safety function.

The rack inserts are intended to be a permanent addition to the spent fuel storage racks. In order to demonstrate that the installed rack inserts remain in place under loads experienced during insertion and removal of fuel assemblies from the spent fuel storage rack cells, the insert, fuel interference and retention forces were measured during clean pool testing. These retention forces are sufficient to ensure the rack inserts remain in place during normal (i.e., fuel handling) conditions as shown by fuel assembly drag forces and abnormal (i.e., seismic) conditions. The expected installation force (less than 1000 lbf), fuel interference/drag force (less than 50 lbf) and minimum retention force (greater than 200 lbf) were measured during the clean pool testing.

In summary, the results of the clean pool testing confirmed the conclusions of the NETCO seismic analysis and provide reasonable assurance that NETCO-SNAP-IN® inserts will perform their intended safety function when installed.

<u>Demonstration Testing (QCNPS SFP)</u>

In addition to the clean pool testing already completed as described above, a demonstration program was completed at QCNPS as previously described in Section 3.1.4 above. The demonstration program testing was performed in two phases to verify acceptability of the Style 1 and Style 2 inserts, also described in Section 3.1.4. This demonstration program testing was performed in the QCNPS SFPs as a validation of the clean pool testing results. In the same manner that a plant modification acceptance test verifies that the installed configuration meets the design, the demonstration testing is a confirmation that the inserts, once installed, meet the interference and retention load testing requirements. The QCNPS specific parameters observed during the demonstration program were: 1) installation force; 2) fuel interference or drag force; and 3) retention force (greater than 100 lbs). It should be noted that, as a consequence of the rack fit issues described in Section 3.1.4, testing on the Style 2 inserts reduced the required retention force to 100 lbf. Section 3.4.4 below shows that this value still provides reasonable assurance that the inserts will perform their intended safety function when installed. Overall, the demonstration results were consistent with the clean pool testing results. Additional detail is provided below.

Insertion Force – The insertion or installation force is developed through the installation tool. This force is developed through the use of an impact mechanism at the top of the tool and the weight of the tool itself. The combined weight of the installation tool and insert will weigh less than 1000 pounds to maintain a load under the hoist limit for the refueling bridge. As demonstrated in the clean pool test and the on-site demonstration test, installation of the insert will not damage the existing SFP storage rack structural integrity or the rack insert itself. The only force that is applied to the racks is through the NETCO-SNAP-IN® rack insert. The yield stress of the aluminum-boron carbide composite material is less than the yield stress of the SFP storage rack material (i.e., stainless steel); therefore, the applied stress on the SFP storage rack is significantly less than the allowable stress for stainless steel SFP storage racks and, therefore, will not damage the existing racks. Also, the installation tool and insert combined weight of less than 1000 pounds is less than 1800 pounds, which is the value defined as a heavy load at QCNPS; therefore, the insert and installation tool may be moved over the spent fuel in the storage racks.

Drag Force – The drag force or interference between the fuel assembly and insert was measured during Phase 1 of the demonstration program testing. The maximum drag force was confirmed to be significantly less than 50 lbf. This shows there is adequate margin such that an insert would not be removed during bundle withdrawal given the minimum observed retention force of greater than 100 lbf. Drag force values from Phase 1 testing were minimal; subsequently, Phase 2 testing confirmed there was no noticeable interference with a dummy fuel assembly.

Retention Force – Acceptance testing was performed to measure the force required to remove an insert from a fuel storage rack cell once installed (i.e., the retention force). That force was greater than 100 lbf which meets the QCNPS specific design criteria for seismic accelerations and stress relaxation (see Section 3.4.4 below).

In summary, the results of the demonstration program testing further supports the conclusions of the NETCO structural analysis and provide reasonable assurance that NETCO-SNAP-IN® inserts will perform their intended safety function when installed in the QCNPS SFP.

3.4.4 Stress Relaxation in the Absorber Rack Inserts

During installation, the NETCO-SNAP-IN® rack inserts are compressed from an initial bend angle of greater than 90 degrees to fit in the square dimensions of the spent fuel storage rack cell interior. Once installed, the internal stresses in the rack inserts may be susceptible to relaxation over time. This relaxation would result in less force against the spent fuel storage rack cell wall and lower retention force. An analysis of stress relaxation in aluminum alloys has been performed to establish the expected performance of the rack inserts in this regard (See Attachment 8, Section 4.1).

During initial NETCO prototype testing, it was demonstrated that the Rio-Tinto Alcan W1100N-series alloy had similar mechanical characteristics to Type 6061 aluminum alloys. Reference 3 details the stress relaxation performance of 6061-T6 alloy after 1000 hours at various temperatures. The data show approximately 15 percent stress relaxation after 1000 hours at 100°C (212°F).

The average bulk water temperature of the Unit 2 QCNPS SFP from January 1, 2011 to December 31, 2012 was approximately 93°F (note that the Unit 1 SFP has no temperature indication; however, the Unit 2 SFP temperature is representative of the Unit 1 SFP as the transfer gate between the pools is typically maintained open as specified in procedure QCFHP 1200-14, "Installation and Removal of Transfer Canal Gates," Revision 5). Stress relaxation at this temperature is expected to be less than 15 percent over 1000 hours. As an upper limit, data for Type AA1100-H112 series aluminum alloy was analyzed to estimate total stress relaxation after 20 years of service using QCNPS specific SFP temperature data. Reference 2 includes time under strain measurements up to 10,000 hours. These measurements were fit to a mathematical model that was determined based on the empirical data. The results of that analysis shows that the Type AA1100-H112 series aluminum alloy is expected to experience an approximate stress reduction of 58.5 percent over 20 years based on an average bulk water temperature of 92.5°F.

Given the reduced elongation of the Rio-Tinto Alcan W1100N-series composite material in comparison with AA1100-H112 series aluminum alloy, this stress relaxation is considered an upper limit for the performance of the Rio-Tinto Alcan W1100N series material used to fabricate the NETCO-SNAP-IN® rack inserts.

In the case of a 58.5 percent reduction in retention force over 20 years, the inserts would still maintain greater than 41.5 lbf of retention force within the cell (i.e.,58.5 percent reduction of the 100 lbf minimum retention force) required to remove an insert, verified during the demonstration testing program. The 41.5 lbf retention force is adequate to maintain the inserts in their required position under Safe Shutdown Earthquake (SSE) conditions based on seismic accelerations present at the QCNPS location. The QCNPS design basis seismic event has a vertical acceleration less than 1.0g; therefore, the reduction in retention force due to stress relaxation is acceptable.

Using data for pure AA1100-H112 aluminum alloy is a conservative approach to estimating relaxation for the boron carbide-reinforced Rio-Tinto Alcan W1100N-series material. Stress relaxation in boron carbide reinforced W1100N-series aluminum is less than for the AA1100-series pure alloy because of the presence of the reinforcing boron carbide. In addition, as part of the coupon testing program, the stress relaxation criteria will remain at a 50% limit (i.e., a 50% reduction of the 100 lbf minimum retention force) as the Rio-Tinto Alcan W1100N-series material is not expected to experience stress relaxation as severe as the analyzed AA1100-H112 series aluminum alloy. This also maintains assurance that the design specification of 50 lbf minimum retention force is met as shown in Table 3.9-7.

3.5 Structural

A structural analysis has been performed to show that the in-service loads on the NETCO-SNAP-IN® rack insert during normal and seismic conditions are insufficient to cause an operational failure of the rack insert. An operational failure in this context is the inability of the rack insert to perform its intended function as a neutron absorber or to maintain the critical characteristics to which it was manufactured.

The rack insert has a pre-installed angle of greater than 90 degrees. After installation, the insert will be at approximately 90 degrees. The stress on the structure of the existing SFP storage racks due to the force exerted from the rack insert has been evaluated. The combined weight of the tool and insert during installation is less than 1000 pounds. As demonstrated in the clean pool test and the on-site demonstration test, installation of the insert will not damage the existing SFP storage rack structural integrity or the rack insert itself. As previously noted in Section 3.4.3 above, the only force that is applied to the racks is through the NETCO-SNAP-IN® rack insert. The yield stress of the aluminum-boron carbide composite material is less than the yield stress of the SFP storage rack material (i.e., stainless steel); therefore, the applied stress on the SFP storage rack is significantly less than the allowable stress for stainless steel SFP storage racks and, therefore, will not damage the existing racks.

The structural analysis of the SFP racks has determined that the NETCO-SNAP-IN® inserts meet all of the specified design requirements; and the design basis load combinations continue to be bounded by the existing SFP calculations.

The structural analysis prepared by NETCO addressed the structural integrity of the NETCO-SNAP-IN® neutron absorber insert and the spent fuel storage rack in the QCNPS SFPs. The analysis addressed dead loads, including internal stresses in the installed insert and external forces upon the rack walls, and live loads including their impact on system, structures and components (SSCs) during a seismic event.

The dead load analysis documented that each insert will be pre-loaded during installation by compressing it from its initial greater than 90 degree bend angle to its installed approximate 90 degree bend angle. The analysis, using conservative handbook equations for bending, showed that the maximum internal stresses developed in the inserts are less than the ultimate strength of the material used to manufacture the insert and is thus acceptable. Further finite element analysis showed that the maximum internal stresses developed in the inserts are less than the yield strength of the material.

The test results from the demonstration program and the corresponding minimum retention force criteria (i.e., 100 pounds minimum) confirm that sufficient horizontal and vertical restraint exist to prevent the inserts from displacing during normal plant operations or a design basis seismic event, and are subsequently considered to be integral with the spent fuel storage racks.

The external stresses imparted to the spent fuel storage rack wall during the insert installation were calculated and determined to be negligible. The normal force which prevents the insert from moving under seismic loading induces a shear stress along the contact region of the fuel rack. The shear stress ratio resulting from these normal forces was calculated to be below one percent.

The potential for impact between the spent fuel elements and the structure of the spent fuel rack was considered. Because the rack inserts are installed between the fuel element and the rack, they reduce the distance that would be traveled before an impact would occur. The reduction in travel distance would result in a lower velocity at impact and reduced impact forces. Therefore, the stresses on a fuel element due to an impact with an insert would be significantly lower than an equivalent impact with the spent fuel rack structure.

3.6 Seismic

A calculation was performed to evaluate the effects of the installation of the inserts on the applicable existing plant SSCs. The calculation documents that the inserts, when installed, become integral with the SFP storage racks. The calculation documents that sufficient margin exists and the qualification of the QCNPS SFP storage rack is not compromised. Note that the impact of a seismic event on the inserts themselves was previously discussed in Section 3.4.4.

Additional calculations were performed to determine the effects of the installation of the inserts on the Reactor Building structure, SFP, and fuel pool liner. These calculations document that sufficient margin exists and the qualification of the QCNPS Reactor Building, SFP and fuel pool liner is not compromised. Additionally, the force exerted to the insert by a fuel bundle during a seismic event will have minimal effects and the integrity of the inserts will not be compromised.

The spent fuel storage racks are designed to comply with Seismic Category I requirements in accordance with NRC Regulatory Guide 1.29, "Seismic Design Classification," Revision 3, September 1978. The design of the spent fuel storage racks is in accordance with Standard Review Plan (SRP) Section 3.8.3, "Concrete and Steel Internal Structures of Steel or Concrete Containments," Revision 0, November 1975, Section 3.8.4, "Other Seismic Category I Structures," Revision 0, November 1975, and Section 9.1.2, "New and Spent Fuel Storage," Revision 2, March 1979 (as applicable to spent fuel racks). As a result, the rack inserts are also classified as Seismic Category I.

Two load effects associated with the use of the rack inserts have been evaluated:

- First, the impact loads of the fuel assemblies on the NETCO-SNAP-IN® rack inserts during the design basis seismic event were evaluated. During the event, fuel assemblies will impact the spent fuel storage rack cell walls and installed rack inserts due to horizontal acceleration of the individual fuel racks. With the NETCO-SNAP-IN® rack inserts installed, the fuel assembly-to-storage rack impact forces will be reduced as the horizontal distance available for fuel assembly acceleration will be reduced by the thickness of the rack insert.

- Second, the impact of the NETCO-SNAP-IN® rack inserts on the spent fuel storage racks was reviewed. The existing spent fuel storage racks were qualified by an analysis documented in a Joseph Oat Corporation Report, "Licensing Report on High Density Spent Fuel Racks for Quad Cities Units 1 and 2," Revision 1, dated June 1981, submitted in a letter from T. J. Rausch (Commonwealth Edison Company (now EGC)) to H. R. Denton (NRC), "Quad Cities Station Units and 2, Transmittal of Revision to the Licensing Report on High Density Fuel Racks," dated June 24, 1981. The qualification analysis used a "stick" model of the spent fuel rack with 1-D elements, springs, dampers, and gap elements to model the dynamic behavior of the racks under a time-history seismic load. An assessment of the impact on the rack deflections and stresses has been performed prompted by the installation of the NETCO-SNAP-IN® rack inserts. This assessment was based on the rack conditions that were analyzed in the attached Holtec Licensing Report (i.e., Attachment 4) which considered different rack geometries and loading conditions (i.e., full of fuel, half full of fuel, and empty). The analysis concluded that the qualification of the spent fuel rack remains valid after the installation of the NETCO-SNAP-IN® rack inserts.

The combined weight of the insert and installation tool is less than 1000 lbs. The installation force does not overstress the spent fuel storage rack or the inserts as previously discussed in Section 3.4.3 above. The test results from the demonstration program and the corresponding minimum retention force criteria (i.e., 100 pounds) confirm that sufficient margin exists to ensure that the inserts remain in the installed location during fuel moves and during a design basis seismic event.

3.7 Thermal-Hydraulic

Installation of the rack inserts does not alter the allowed maximum number of fuel assemblies, maximum heat loads, or methods of determining decay heat loads in the SFP. The rack inserts displace a small amount of water inventory in the SFP and may reduce natural circulation flow in the region within the SFP storage rack cell but outside of the fuel channel/assembly. This has an insignificant impact on the heat transferred to the SFP and the heat removal capability of the SFP cooling system. The volume of water displaced by the rack inserts is negligible compared to the total SFP water volume.

Fuel assembly heat removal via natural circulation through the fuel assembly itself is not significantly affected. There is also a negligible impact on the time-to-boil and boil-off rate for the SFP. Therefore, there is an insignificant overall effect on the thermal-hydraulic design of the SFP due to installation of the rack inserts.

3.8 Accident Conditions

3.8.1 Accident Considerations Related to Criticality

The spent fuel rack configuration was analyzed for credible accident scenarios. The scenarios considered are presented in the bulleted list that follows and are discussed in Section 2.6 of Attachment 4.

- SFP temperature exceeding the normal range
- Dropped assemblies
- Storage cell distortion
- Missing insert
- Misloaded fuel assembly (a fuel assembly in the wrong location within the storage rack)/Missing an insert
- Mislocated fuel assembly (a fuel assembly in the wrong location outside the storage rack)
- Miss-installment of an insert on wrong sides of a cell
- Insert mechanical wear
- Rack movement

As discussed in Attachment 4, the criticality analysis performed showed a storage rack maximum k_{eff} less than 0.95 with a 95% probability at a 95% confidence level.

3.8.2 Fuel Handling Accident

Use of the NETCO-SNAP-IN® rack insert does not affect the radiological consequences of the fuel handling accident in the SFP. The design basis fuel handling accident assumes that during a refueling operation, a fuel assembly and refueling mast are dropped on top of irradiated fuel in the core. This scenario bounds a fuel handing accident in the SFP because the source term of the longer-cooled fuel in the SFP available for release as a result of this event is less than that for the fuel in the core 24 hours after shutdown. The radiological consequences of a drop over the SFP are discussed in Section 15.7.2 of the QCNPS UFSAR. Because the rack insert and removal/installation tool are of similar geometry and lighter in weight than a fuel assembly and refueling mast, use of the rack insert and removal/installation tool is bounded by these events.

3.9 Rack Insert Surveillance Program

3.9.1 Surveillance Program Overview

Rio-Tinto Alcan provides an aluminum boron carbide composite from which the NETCO-SNAP-IN® rack inserts are fabricated. Rio-Tinto Alcan material has been previously approved for use in spent fuel racks as described in the LaSalle County Station, Units 1 and 2, Safety Evaluation, dated January 28, 2011 (ADAMS Accession No. ML110250051) and Peach Bottom Atomic Power Station, Units 2 and 3, Safety Evaluation, dated May 21, 2013 (ADAMS Accession No. ML13114A929). Initial corrosion testing in simulated SFP conditions has been described in Section 3.3.2 above. EGC will implement three surveillance programs described in Sections 3.9.2, 3.9.3, and 3.9.4 below that consist of monitoring the physical properties of the absorber material, performing periodic neutron attenuation testing to confirm the physical properties, and observing the inserts for wear. If an abnormal condition is confirmed, the condition would be entered into EGC's corrective action program for disposition.

3.9.2 Fast Start Coupon Surveillance Program

The fast start coupon surveillance program was a one-time program implemented at LSCS before the first deployment of NETCO-SNAP-IN® rack inserts. This program consisted of a series of 24 coupons cut from extra Rio-Tinto Alcan composite produced for the LSCS demonstration program. This coupon string was installed in the LSCS SFP. The coupons cut from the demonstration program Rio-Tinto Alcan material were 2x4 inches and had two 0.25 inch diameter holes along the top and bottom edge. The purpose of the fast start program is to provide early performance data on the Rio-Tinto Alcan composite in a SFP environment in support of prototype fabrication activities for the NETCO-SNAP-IN® rack inserts product line.

Following each LSCS refueling outage, the fast start coupons are placed in a spent fuel storage rack cell surrounded by eight cells with freshly discharged fuel which remain there until the next refueling outage. In this manner the gamma energy deposition and temperatures of the coupons will be maximized. Two coupons will be removed from the string approximately every six months and sent to a qualified laboratory for testing and inspection. The coupons have been subjected to pre-installation characterization and are post-test characterized.

The fast-start surveillance program at LSCS was initiated as part of the product development and demonstration effort undertaken by NETCO after EGC decided to employ NETCO-SNAP-IN® rack inserts made from Rio-Tinto Alcan material at LSCS. The Rio-Tinto Alcan material was tested and demonstrated to perform well in the laboratory as part of an 8000-hour accelerated corrosion test in simulated Pressurized Water Reactor (PWR) and BWR pool environments.

The fast start testing program was intended to identify unanticipated insert material performance issues during the demonstration of the first-of-a-kind use of NETCO SNAP-IN® inserts in SFPs. The fast start coupon surveillance program at LSCS was intended to ensure that insert material performance was satisfactory prior to full scale project implementation for EGC. Based on the satisfactory results at LSCS and the similarities of the SFP water chemistry, the program does not need to be duplicated for QCNPS.

The LSCS and QCNPS SFP chemistries and temperatures vary day-to-day; however, in general, are similar with respect to concentrations of potentially corrosive chemicals and normal operating temperature. The LSCS and QCNPS maximum fuel pool temperature licensing limits are 140°F and 150°F, respectively. The normal operating temperature range for the fuel pools at both stations is 70°F–110°F. The chemistry program that governs SFP chemistry for both plants is the same. The requirements for the EGC BWR plant SFP chemistry control program are defined in EGC procedure CY-AB-120-300, "Spent Fuel Pool." The SFP chemistry requirements are also in accordance with Table E-4 of BWRVIP-190, "BWR Water Chemistry Guidelines – 2008 Revision."

Table 3.9-1 below provides a comparison of the significant chemistry parameters between LSCS and QCNPS from April 2012 through April 2013. Note that data is provided for both the Unit 1 and 2 SFPs at QCNPS as each pool is sampled separately and both SFPs will contain NETCO-SNAP-IN® rack inserts. Data is provided for only the Unit 2 SFP at LSCS as the Unit 1 SFP at LSCS does not utilized NETCO-SNAP-IN® rack inserts.

The results of the inspections of the LSCS fast start coupons 23 and 24 are contained in report NET-332-01, Revision 1, "Inspection and Testing of BORAL® and Fast Start Surveillance Coupons from the LaSalle County Units 1 and 2 Stations," (Attachment 10). Twelve additional

LSCS fast start coupons were removed and tested as documented in NET-300054-01, Revision 0, "Inspection and Testing of Fast Start Surveillance Coupons F22-F11 from the LaSalle County Unit 2 Station," (Attachment 11).

There was essentially no change in the Rio-Tinto Alcan composite coupons from their pre-use characterization values. Report NET-259-03, "Material Qualification of Alcan Composite for Spent Fuel Storage," Revision 5 (i.e., Attachment 8) provides an overall qualification of the insert material for both BWR and PWR SFP environments at a range of B_4C loadings (16-25 volume percent) in aluminum which bounds the QCNPS inserts (i.e., 17 volume percent).

Table 3.9-1

Comparison of QCNPS and LSCS Spent Fuel Pool Chemistry

Date	Chloride (ppb)			Conductivity (µS/cm)			Silica (ppb)			Sulfate (ppb)		
	QC1	QC2	LCS2	QC1	QC2	LCS2	QC1	QC2	LCS2	QC1	QC2	LCS2
Apr 2012	0.30-0.46	0.33-0.37	0.67-0.92	0.80-0.84	0.82-0.83	0.88-0.96	409-712	397-720	4377-5228	0.50-0.50	0.50-0.50	0.18-0.23
May 2012	0.32–0.43	0.34-0.50	0.70-1.29	0.81-0.83	0.81-0.83	0.88-0.92	819- 1230	819-1162	4258-5607	0.50-0.56	0.50-0.88	0.23-0.24
Jun 2012	0.45-0.55	0.51-0.56	1.25-1.51	0.77-0.83	0.77-0.83	0.85-0.88	1200-1600	1200-1600	5315-5441	0.50-0.63	0.50-0.50	0.23-0.72
Jul 2012	0.39-0.60	0.37-0.61	1.67-2.12	0.75-0.78	0.75-0.78	0.82-0.86	1800-2463	1800-2463	6273-7293	0.50-0.59	0.50-0.50	1.08-2.15
Aug 2012	0.45-0.58	0.42-0.59	1.15-2.19	0.78-0.79	0.78-0.79	0.75-0.85	2300-2737	2300-2737	6847-7796	0.50-0.64	0.50-0.50	1.00-1.64
Sep 2012	0.36-0.59	0.44-0.53	1.32-2.25	0.71-0.81	0.72-0.81	0.78-0.89	2700-3559	2500-3422	8347-9231	0.50-0.63	0.50-0.50	0.24-1.63
Oct 2012	0.25-0.39	0.30-0.44	1.08-1.21	0.73-0.79	0.74-0.79	0.91-0.95	3150-3457	3200-3525	9257-9801	0.50-0.51	0.50-0.50	0.18-0.24
Nov 2012	0.37-0.49	0.36-0.48	0.54-0.96	0.77-0.80	0.75-0.79	0.71-0.97	3550-4050	3550-4150	6368-9848	0.50-0.50	0.50-0.50	0.18-0.24
Dec 2012	0.42-0.52	0.40-0.50	1.08-1.12	0.78-0.79	0.76-0.77	0.92-0.93	3550-4449	3600-4517	6567-9742	0.50-0.50	0.50-0.50	0.23-0.24
Jan 2013	0.52-0.67	0.54-0.73	0.47-1.12	0.78-0.79	0.77-0.79	0.89-0.93	4311-4654	4311-4900	10111-10842	0.50-0.65	0.50-0.50	0.23-0.24
Feb 2013	0.35-0.75	0.34-0.82	0.43-0.64	0.78-0.79	0.76-0.92	0.86-1.13	410-4964	700-4964	4088-10632	0.50-0.72	0.43-0.51	0.18-0.55
Mar 2013	0.31-0.89	0.29-0.92	0.64-0.75	0.54-0.93	0.61-0.89	0.92-0.94	160-900	180-850	4486-4843	0.50-0.84	0.50-0.83	0.23-0.24
Apr 2013	0.76-0.81	0.82-1.05	0.80-0.80	0.83-0.84	0.82-0.83	0.92-0.93	750-786	786-800	5460-5654	0.50-0.50	0.50-1.15	0.23-0.24

3.9.3 Long-Term Coupon Surveillance Program

The long-term coupon surveillance program at QCNPS will consist of periodic surveillance testing of different types of coupons fastened to two specially designed surveillance "trees." The surveillance "trees" were placed within one of the QCNPS SFPs as part of the first installation campaign of NETCO-SNAP-IN® rack inserts and will reside there as long as the spent fuel storage racks with NETCO-SNAP-IN® rack inserts continue to be used. Periodically, as described below, coupons will be removed and sent to a qualified laboratory for testing.

The types and quantities of the long-term surveillance coupons are described in Table 3.9-2 below. All coupons will be manufactured to the same material specification as the QCNPS rack inserts. Both coupon trees are designed to be inserted into rack cells. The flat coupon tree is designed to hold general and galvanic coupons. These coupons will be monitored for any changes to their physical properties and especially for any changes to their effective areal density or signs of corrosion, which could indicate neutron absorber material degradation. The bent coupon tree is designed to hold coupons at a 90 degree (nominal) bend angle which is, on average, a 5 degree deflection from their as-manufactured dimension. The bend coupons are intended to monitor the performance of the bend region of the inserts, especially stress relaxation and crack formation under the in-service strain to which the inserts are subjected.

Table 3.9-2

Long-Term Surveillance Coupons

Coupon Type	Number	Objective
General	48	(See Table 3.9-3 below)
Bend	24	Track effects along bend radii
Galvanic (bi-metallic)	24	Trend galvanic corrosion with 304LSS, Inconel 718 and Zircaloy coupons

The general and galvanic coupons will be subject to pre- and post-examination according to Table 3.9-3 below.

Table 3.9-3

Long-Term Surveillance General and Galvanic Coupon Characterization

Test	Pre-Characterization	Post-Characterization	Acceptance / Rejection 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 percent
Density	√	√	Any change of +/- 5 percent
Areal Density	√	√	0.0116 Boron-10 g/cm^2 minimum loading
Acid Cleaning		√	N/A
Weight Loss		√	Any change of +/- 5 percent
Corrosion Rate		√	< 0.05 mil/yr
Microscopy		√ **	At the discretion of the test engineer

* Acceptance criteria for length and width change are for general coupons only.
** At the presence of anomalies

The bend coupons will be subject to pre- and post-examination according to Table 3.9-4 below. Areal density testing will be performed on all coupons except bend coupons. Due to geometry constraints, the bend section of the bend coupons cannot be accurately tested for areal density using neutron attenuation methods.

Table 3.9-4

Long-Term Surveillance Bend Coupon Characterization

Test	Pre-Characterization	Post-Characterization	Acceptance / Rejection Criteria
Visual (high resolution digital photo)	√	√	Evidence of visual indications
Thickness	√	√	Min. thickness: 0.005 inch less than nominal thickness Thickness Change: Any change of +0.010 inch / - 0.004 inch
Dry Weight	√	√	Any change of +/- 5 percent
Bend Stress	√	√	Change in stress greater than a rate of 50% / 20yrs**
Acid cleaning		√	N/A
Weight Loss		√	Any change of +/- 5 percent
Microscopy		√ *	At the discretion of the test engineer

* At the presence of anomalies

** Stress relaxation rate is not linear. Stress relaxation will be re-evaluated if 50% is exceeded.

Coupons will not be re-inserted into the fuel pool after removal for inspection. The removal process and handling of inserts creates the potential for coupon damage and once a coupon is removed from service for inspection, it is exposed to the ambient air environment and would no longer provide a representative sample for future inspections. There will be a sufficient number of test coupons installed into the SFP so that coupons will not have to be re-used for future required inspections (see Tables 3.9-2 and 3.9-5).

The frequency for coupon inspection under the long-term surveillance program is shown in the following table.

Table 3.9-5

Frequency for Coupon Inspection

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 304L Stainless Zircaloy Inconel 718	 1 couple every 6 years 1 couple every 6 years 1 couple every 6 years	

3.9.4 Full Rack Insert Surveillance Inspections

3.9.4.1 Insert In-Situ Inspections

Two rack inserts from the Unit 1 SFP will be visually inspected by camera at the frequency described in Table 3.9-6 below to visually monitor for physical deformities such as bubbling, blistering, corrosion pitting, cracking, or flaking. Special attention will be paid to development of any edge or corner defects. The selection of the two inserts will be based on bounding operating conditions for all pool inserts. The parameters that could affect the material properties of the insert are fuel pool water chemistry, pool temperature, and radiation exposure received due to proximity to irradiated fuel.

In the QCNPS SFPs, water chemistry and temperature do not vary among the rack locations throughout the pools. Substantial SFP water mixing is assured by continuous circulation through each SFP by the SFP cooling system. Therefore, each insert location is exposed to essentially the same water chemistry and water temperature. There is no worst case or bounding rack cell location associated with water chemistry or temperature.

The inserts chosen for inspection from the Unit 1 SFP will be those with the highest radiation exposure received from discharged fuel so that the radiation effects will bound all other inserts in the pool. QCNPS will designate two rack cells as test locations so that discharged fuel with the highest burnup can be placed in the cells. Placing discharged fuel with the highest burnup in the test cells after every Unit 1 refueling will ensure they are representative with respect to radiation exposure. The proposed strategy will not adversely impact B.5.b fuel pool loading requirements. Placing the highest exposed discharged fuel in the test locations will be administratively controlled.

Table 3.9-6

Frequency for Full Insert Inspection

Inspection Type	Qty / Interval	Objective
In-Situ Inspection	2 inserts every 2 years	Visually Monitor for Signs of Degradation
Removal Inspection	1 insert every 10 years	Test for Wear Along Insert Length and Adequate Retention Force

3.9.4.2 Insert Removal for Inspection

The limiting high duty spent fuel storage rack cell locations will be identified for this surveillance program. These locations will be monitored for fuel insertion and removal events to ensure that their service bounds that of the general population of storage locations. Full inserts removed for inspections will be subject to pre- and post-examination according to Table 3.9-7 to verify the inserts have sustained uniform wear over their service life. As described in Table 3.9-6, one insert will be removed every 10 years.

Table 3.9-7

Long-Term Surveillance Full Insert Removal Inspection Characterization

Test	Pre-Characterization	Post-Characterization	Acceptance / Rejection Criteria
Visual (high resolution digital photo)	√	√	Evidence of visual indications
Thickness	√	√	Min. thickness: 0.005 inch less than nominal thickness Thickness Change: Any change of +0.010 inch / - 0.004 inch
Retention Force		√	Retention force less than 50 lbf.

Inserts removed from service for inspection will not be reinstalled. The removal process and handling of inserts creates the potential for insert damage. In addition, once an insert is removed from service for inspection, it is exposed to the ambient air environment and would no longer provide a representative sample for future inspections. Thus, removed inserts will be replaced with new inserts.

As described in Section 3.4.2 above, minimal service wear is expected within the active fuel region on the inserts due to adequate clearance between the fuel assembly and the insert. Drag/interference testing confirmed there was no noticeable interference and, therefore, no means of generating additional wear.

If service wear on an insert was to occur, it would occur as the result of the insertion and removal of a fuel assembly in and out of the rack cell. The rack cell with the most fuel assembly insert and removal cycles will represent a bounding case for all the pool rack cells. The number of fuel assembly inserts and removals in and out of each rack cell containing a NETCO-SNAP-IN® rack insert will be tracked and documented. The insert in the rack cell that has the most fuel move cycles will be the insert chosen for inspection. Inspecting the insert that had the most fuel assembly movements will ensure it is bounding with respect to wear for all inserts in the pool.

3.10 Installation and Removal of Rack Inserts

A typical installation tool with a NETCO-SNAP-IN® rack insert engaged is shown in Figure 2-3 of Attachment 8. This tool has been modified from that shown in Attachment 8 for use at QCNPS. The design weight of the installation tool with the rack insert is limited by the capacity of the SFP refuel bridge monorail hoist which is bounded by the fuel handling accident and QCNPS heavy load restrictions.

A separate removal tool has been designed and fabricated for rack insert removal. Any required removal of rack inserts will be performed using the appropriate configuration controls and confirmation of restored configuration. The weight of the removal tool is less than the weight of the installation tool and therefore remains within the QCNPS heavy load restrictions.

3.11 Summary and Conclusions

The proposed change is necessary to resolve the issue of Boraflex degradation in the QCNPS, Units 1 and 2 SFP storage racks. The proposed change to install NETCO-SNAP-IN® rack inserts in the SFP storage racks has been evaluated and shown to be a safe and effective manner in which to resolve the Boraflex degradation issue for the remaining period of time that spent fuel needs to be stored in the QCNPS SFP storage racks.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

10 CFR 50.68, "Criticality accident requirements," paragraph (b)(4) states that the k_{eff} of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity and flooded with unborated water must not exceed 0.95, at a 95 percent probability, 95 percent confidence level. The rack insert criticality analysis, provided as Attachment 4 to this submittal, demonstrates that this requirement is met.

Paragraph (b)(7) of 10 CFR 50.68 states that the maximum nominal U-235 enrichment of the fresh fuel assemblies is limited to 5.0 percent by weight. QCNPS new fuel is below 5.0 percent by weight U-235 enrichment.

The following General Design Criteria (GDC) are applicable to this amendment request. It should be noted that, although QCNPS is not formally committed to the GDC due to the vintage of the station, an evaluation was performed addressing the QCNPS conformance with the GDC. This evaluation is documented in the UFSAR Section 3.1, "Conformance with NRC General Design Criteria." This evaluation concluded that QCNPS fully satisfies the intent of the (then draft) GDC.

GDC 5, "Sharing of structures, systems, and components," specifies that structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units. The spent fuel storage pool has been designed to withstand the anticipated earthquake loadings as a Class I structure. Each unit has its own SFP measuring 33 x 41 feet. The fuel storage pools of Units 1 and 2 are connected by a double-gated transfer canal. The fuel pool is a reinforced-concrete structure, lined with seam-welded, stainless steel plate, welded to reinforcing members embedded in concrete. The 3/16-inch stainless steel liner will prevent leakage in the unlikely event the concrete develops cracks. To avoid unintentional draining of the pool, there are no penetrations that would permit the pool to be drained below a safe storage level. The passage between the fuel storage pool and the reactor cavity is located above the reactor vessel, is constructed with two, double-sealed gates and has a monitored drain between the gates. This arrangement permits detection of leaks from the passage and repair of a leaking gate. The depth of water in the fuel storage pool is approximately 37 feet 9 inches and the depth of the water in the transfer canal during refueling is 22 feet 9 inches.

GDC 62, "Prevention of criticality in fuel storage and handling," states that criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations. The evaluation of QCNPS's conformance with GDC 62 is discussed in Section 9.1.2, "Spent Fuel Storage," of the QCNPS UFSAR. The NETCO-SNAP-IN® rack insert criticality analysis has been performed to demonstrate that k_{eff} will remain less than or equal to 0.95 with no credit taken for the Boraflex neutron poison material present in the spent fuel storage racks in the final configuration.

4.2 Precedent

The NRC has previously approved the use of NETCO-SNAP-IN® rack inserts as an alternate method of criticality control to address Boraflex degradation as documented in the LaSalle County Station, Units 1 and 2, Safety Evaluation, dated January 28, 2011 (ADAMS Accession No. ML110250051), and Peach Bottom Atomic Power Station, Units 2 and 3, Safety Evaluation, dated May 21, 2013 (ADAMS Accession No. ML13114A929). Thus, this proposed amendment would be the third use of NETCO-SNAP-IN® rack inserts for neutron control in an EGC nuclear station SFP.

4.3 No Significant Hazards Consideration

In accordance with 10 CFR 50.90, "Application for amendment of license, construction permit, or early site permit," Exelon Generation Company, LLC (EGC) requests an amendment to Renewed Facility Operating License Nos. DPR-29 and DPR-30 for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The proposed change requests NRC approval for use of an alternate mechanism other than the currently installed Boraflex neutron absorber panels for criticality control in the spent fuel pool. Specifically, EGC is requesting to use NETCO-SNAP-

IN® neutron absorbing rack inserts that will be installed in the spent fuel pool storage rack cells and credited as a replacement for the neutron absorbing properties of the existing Boraflex panels which have exhibited degradation over time. The NETCO-SNAP-IN® rack inserts will provide an alternative method of ensuring that neutron absorption in the Unit 1 and Unit 2 spent fuel pool storage racks continues to meet the effective neutron multiplication factor, k_{eff}, criticality control requirement without reliance on Boraflex.

According to 10 CFR 50.92, "Issuance of amendment," paragraph (c), a proposed amendment to an operating license involves no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated; or

(2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or

(3) Involve a significant reduction in a margin of safety.

EGC has evaluated the proposed change for QCNPS using the criteria in 10 CFR 50.92, and has determined that the proposed change does not involve a significant hazards consideration. The following information is provided to support a finding of no significant hazards consideration.

Criteria

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No

   The proposed change revises Technical Specification (TS) 4.3.1 to permit installation of NETCO-SNAP-IN® rack inserts in spent fuel pool storage rack cells. The change is necessary to ensure that, with continued Boraflex degradation over time, the effective neutron multiplication factor, k_{eff}, is less than or equal to 0.95, if the spent fuel pool is fully flooded with unborated water as required by 10 CFR 50.68, "Criticality accident requirements." Because the proposed change pertains only to the spent fuel pool, only those accidents that are related to movement and storage of fuel assemblies in the spent fuel pool could potentially be affected by the proposed change.

   The installation of NETCO-SNAP-IN® rack inserts does not result in a significant increase in the probability of an accident previously analyzed because there are no changes in the manner in which spent fuel is handled, moved, or stored in the rack cells. The probability that a fuel assembly would be dropped is unchanged by the installation of the NETCO-SNAP-IN® rack inserts. These events involve failures of administrative controls, human performance, and equipment failures that are unaffected by the presence or absence of Boraflex and the rack inserts.

   The installation of NETCO-SNAP-IN® rack inserts does not result in a significant increase in the consequences of an accident previously analyzed because there is no change to the fuel assemblies that provide the source term used in calculating the radiological consequences of a fuel handling accident. In addition, consistent with the current design, only one fuel assembly will be moved at a time. Thus, the consequences of dropping a fuel assembly onto any other fuel assembly or other structure remain bounded by the previously analyzed fuel handling accident. The proposed change does not affect the effectiveness of the other engineered design features, such as filtration systems, that limit the offsite dose consequences of a fuel handling accident.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No

   Onsite storage of spent fuel assemblies in the QCNPS, Units 1 and 2 spent fuel pools is a normal activity for which QCNPS has been designed and licensed. As part of assuring that this normal activity can be performed without endangering the public health and safety, the ability to safely accommodate different possible accidents in the spent fuel pool have been previously analyzed. These analyses address accidents such as radiological releases due to dropping a fuel assembly; and potential inadvertent criticality due to misloading a fuel assembly. The proposed spent fuel storage configuration utilizing the NETCO-SNAP-IN® rack inserts does not change the method of fuel movement or spent fuel storage and does not create the potential for a new accident. The proposed change also allows for the continued use of spent fuel pool storage rack cells with degraded Boraflex within those spent fuel pool storage rack cells; however, no credit is taken for the Boraflex.

   The rack inserts are passive devices. These devices, when inside a spent fuel storage rack cell, perform the same function as the previously licensed Boraflex neutron absorber panels in that cell. The NETCO-SNAP-IN® rack inserts do not add any limiting structural loads or adversely affect the removal of decay heat from the assemblies. No change in total heat load in the spent fuel pool is being made. The insert devices will maintain their design function over the life of the spent fuel pool. The existing fuel handling accident, which assumes the drop of a fuel assembly and refueling mast, bounds the drop of a rack insert and/or rack insert installation tool. This proposed change does not create the possibility of misloading an assembly into a spent fuel storage rack cell.

   Based on the above information, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No

   The NETCO-SNAP-IN® rack inserts are being installed to restore the spent fuel pool criticality margin, compensating for the degraded Boraflex neutron absorber. The NETCO-SNAP- IN® rack inserts, once approved and credited, will replace the existing Boraflex as the credited neutron absorber for controlling spent fuel pool reactivity, even though the Boraflex absorber will remain in place.

QCNPS TS 4.3, "Fuel Storage," Specification 4.3.1.1.a requires the spent fuel storage racks to maintain the effective neutron multiplication factor, k_{eff}, less than or equal to 0.95 when fully flooded with unborated water, which includes an allowance for uncertainties. Therefore, for spent fuel pool criticality considerations, the required safety margin is 5 percent.

The proposed change ensures, as verified by the associated criticality analysis, that k_{eff} continues to be less than or equal to 0.95, thus preserving the required safety margin of 5 percent.

In addition, the radiological consequences of a dropped fuel assembly, considering the installed NETCO-SNAP-IN® rack inserts, remain unchanged as the anticipated fuel damage due to a fuel handling accident is unaffected by the addition of the inserts in the spent fuel pool storage cells. The proposed change also does not increase the capacity of the Unit 1 and Unit 2 spent fuel pools beyond the current capacity of 3,657 and 3,897 fuel assemblies respectively.

Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above evaluation, EGC concludes that the proposed amendment presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and accordingly, a finding of no significant hazards consideration is justified.

4.4 Conclusions

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

5.0 ENVIRONMENTAL CONSIDERATION

EGC has evaluated this proposed operating license amendment consistent with the criteria for identification of licensing and regulatory actions requiring environmental assessment in accordance with 10 CFR 51.21, "Criteria for and identification of licensing and regulatory actions requiring environmental assessments." EGC has determined that these proposed changes meet the criteria for a categorical exclusion set forth in paragraph (c)(9) of 10 CFR 51.22, "Criterion for categorical exclusion; identification of licensing and regulatory actions eligible for categorical exclusion or otherwise not requiring environmental review," and as such, has determined that no irreversible consequences exist in accordance with paragraph (b) of 10 CFR 50.92, "Issuance of amendment." This determination is based on the fact that these changes are being proposed as an amendment to the license issued pursuant to 10 CFR 50, "Domestic Licensing of Production and Utilization Facilities," which changes a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, "Standards for Protection Against Radiation," or which changes an inspection or a surveillance requirement, and the amendment meets the following specific criteria:

(i) The amendment involves no significant hazards consideration.

As demonstrated in Section 4.3, "No Significant Hazards Consideration," the proposed change to use NETCO-SNAP-IN® rack inserts does not involve any significant hazards consideration.

(ii) There is no significant change in the types or significant increase in the amounts of any effluent that may be released offsite.

The proposed change to credit NETCO-SNAP-IN® rack inserts for criticality control in the spent fuel pool does not result in an increase in power level, does not increase the production nor alter the flow path or method of disposal of radioactive waste or byproducts. It is expected that all plant equipment would operate as designed in the event of a fuel handling accident to minimize the potential for offsite release of radioactive effluents. The addition of NETCO-SNAP-IN® rack inserts has no impact on all other abnormal operating scenarios, Effluent releases during normal at-power operations are also unaffected by this change, and thus, there will be no significant change in the amounts of radiological effluents released offsite.

Based on the above evaluation, the proposed change will not result in a significant change in the types or significant increase in the amounts of any effluent released offsite.

(iii) There is no significant increase in individual or cumulative occupational radiation exposure.

There is no change in individual or cumulative occupational radiation exposure due to the proposed change. Specifically, the addition of NETCO-SNAP-IN® rack inserts to the spent fuel pool will not increase the current radiation levels near the pool area nor will it affect the normal radiation levels in any other area of the plant. The proposed action will also not change the level of controls or methodology used for the processing of radioactive effluents or handling solid radioactive waste.

Therefore, in accordance with 10 CFR 51.22, paragraph (b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 REFERENCES

1. J. R. Davis, "Corrosion of Aluminum and Aluminum Alloys," ASM International, dated November 2000

2. M. Bauccio, "ASM Metals Reference Book," Third Edition, ASM International, dated April 2003

3. K. Farrell, "ORNL/TM-13049 Assessment of Aluminum Structural Materials for Service Within the ANS Reflector Vessel," Oak Ridge National Laboratory, dated August 1995

4. John Gilbert Kaufman, "Properties of Aluminum Alloys," ASM International, dated 1999

5. NRC Interim Staff Guidance DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," Revision 0

6. Letter from T. J. Orf (NRC) to M. Nazar (Florida Power and Light Company), "St. Lucie Plant, Unit 2 – Issuance of Amendment Regarding New Fuel Vault and Spent Nuclear Fuel Pool Nuclear Criticality Analysis (TAC No. ME8782)," (ML12263A224) [NRC Safety Evaluation for CASMO-4 code]

ATTACHMENT 2

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TS Page 4.0-2 (Units 1 and 2)

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. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1.2 of the UFSAR; ~~and~~

b. A nominal 6.22 inch center to center distance between fuel assemblies placed in the 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 elevation 666 ft 8.5 inches.

4.3.3 Capacity

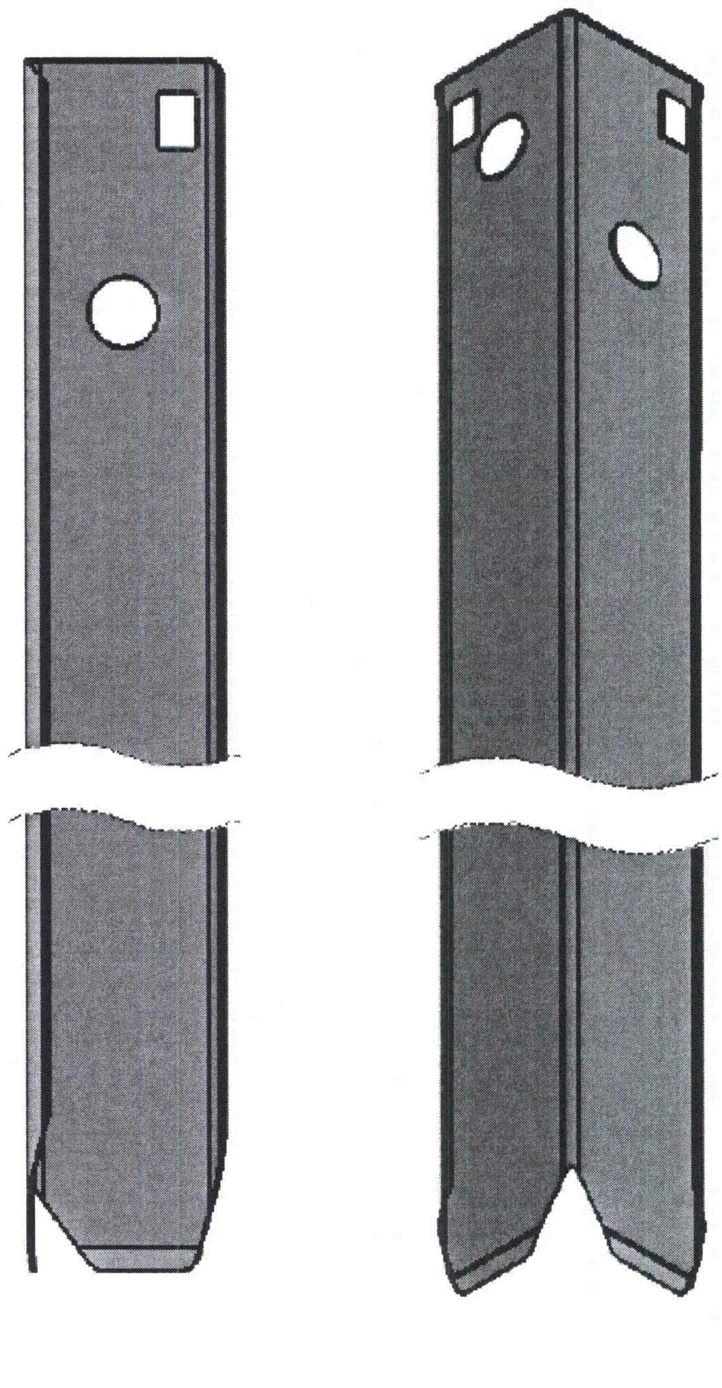
The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 3657 fuel assemblies for Unit 1 and 3897 fuel assemblies for Unit 2.

c. The combination of U-235 enrichment and gadolinia loading shall be limited to ensure fuel assemblies have a maximum k-infinity of 0.9131 as determined at 4°C (39.2°F) in the normal spent fuel pool in-rack configuration; and

d. The installed neutron absorbing rack inserts having a Boron-10 areal density ≥ 0.0116 g/cm^2.

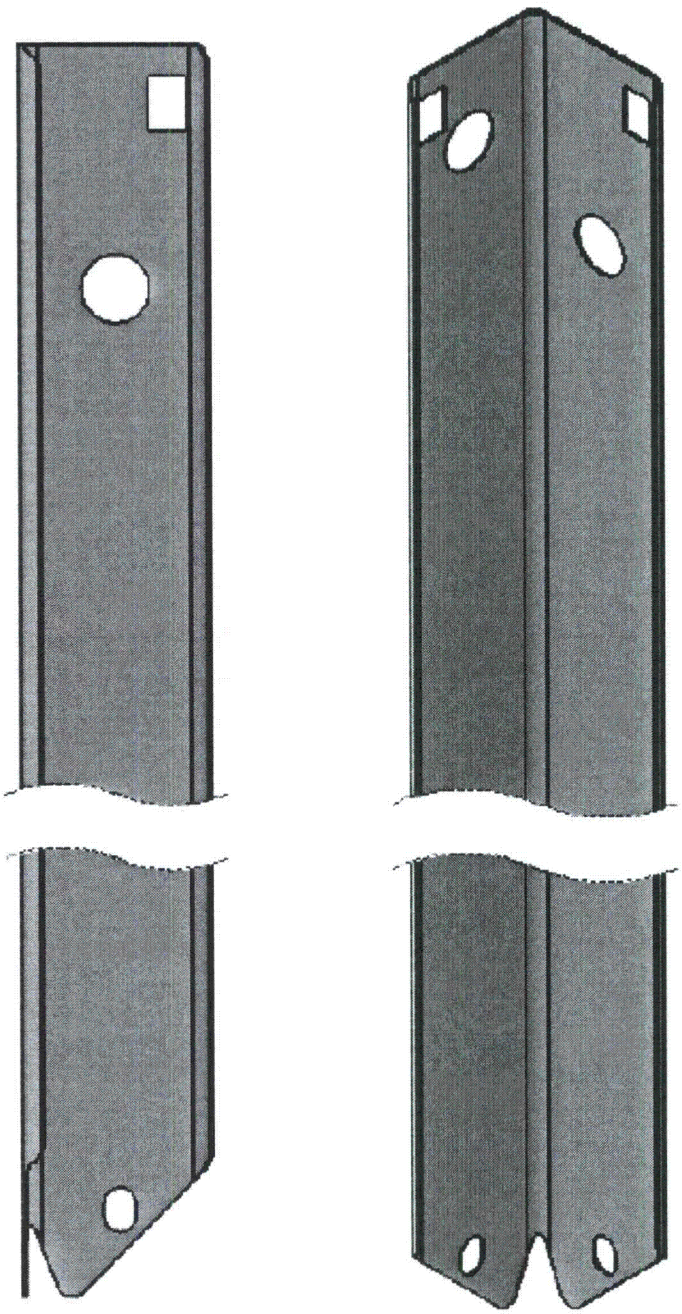
ATTACHMENT 3a

Figure of a Typical NETCO-SNAP-IN® Rack Insert
Style 1



ATTACHMENT 3b

Figure of a Typical NETCO-SNAP-IN® Rack Insert
Style 2



ATTACHMENT 7

Holtec International Affidavit
Requesting Proprietary Reports be Withheld from Public Disclosure
Document ID 2127005

HOLTEC INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

ID: 2127005
May 15, 2013

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

Subject: Affidavit requesting proprietary reports (HI-2125245 and HI-2104790), which will be submitted as part of the Quad Cities Units 1 & 2 Spent Fuel Pool storage Rack Insert License Amendment Request, to be withheld from public disclosure due to their proprietary nature.

In accordance with 10 CFR 50.90, Exelon Generation Company, LLC (EGC) requests a proposed change to modify the Technical Specifications (TS) to include the use of neutron absorbing spent fuel pool rack inserts (i.e., NETCO-SNAP-IN® rack inserts) for the purpose of criticality control in the spent fuel pools at Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2.

In support of the proposed change, proprietary version of the two reports (see below) prepared by Holtec International is being submitted by Exelon.

1. Holtec International Report No. HI-2125245, "Licensing Report for Quad Cities Criticality Analysis for Inserts" Revision 2 (Proprietary Version).

2. Holtec International Report No. HI-2104790, Revision 1, "Nuclear Group Computer Code Benchmark Calculations" (Proprietary).

Holtec International requests that these documents be withheld from public disclosure in accordance with 10 CFR 2.390. A non-proprietary version of Holtec International Report HI-2125245 is being submitted as part of the package. Holtec Report, HI-2104790, is considered proprietary in its entirety and; therefore, has no non-proprietary version. Enclosure 1 to this letter is an affidavit prepared in accordance with 10 CFR 2.390 requesting proprietary information to be withheld from public disclosure.

If you have any questions, please contact me at 856-797-0900, Extn 3663.

HOLTEC INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

Sincerely,

Debabrata (Debu) Mitra-Majumdar, Ph.D.
Corporate Director – Engineering Analyses
Holtec International

cc (letter only):
Joseph Bauer, Exelon (via email)
Rosanne Carmean, Exelon (via email)
William McGaffigan, Exelon (via email)

List of Enclosure:

Enclosure 1: Affidavit prepared in accordance with 10 CFR 2.390 requesting proprietary information to be withheld from public disclosure.

AFFIDAVIT PURSUANT TO 10 CFR 2.390

I, Debabrata (Debu) Mitra-Majumdar, being duly sworn, depose and state as follows:

(1) I have reviewed the information described in paragraph (2) which is sought to be withheld, and am authorized to apply for its withholding.

(2) The information sought to be withheld is information provided in the following reports.

a. Holtec International Report No. HI-2125245, "Licensing Report for Quad Cities Criticality Analysis for Inserts" Revision 2 (Proprietary Version).

b. Holtec International Report No. HI-2104790, Revision 1, "Nuclear Group Computer Code Benchmark Calculations" (Proprietary).

These reports contain Holtec Proprietary information.

(3) In making this application for withholding of proprietary information of which it is the owner, Holtec International relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4) and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10CFR Part 9.17(a)(4), 2.390(a)(4), and 2.390(b)(1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

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(4) Some examples of categories of information which fit into the definition of proprietary information are:

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

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

c. Information which reveals cost or price information, production, capacities, budget levels, or commercial strategies of Holtec International, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future Holtec International customer-funded development plans and programs of potential commercial value to Holtec International;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs 4.a, 4.b and 4.e, above.

(5) The information sought to be withheld is being submitted to the NRC in confidence. The information (including that compiled from many sources) is of a sort customarily held in confidence by Holtec International, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by Holtec International. No public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for

maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within Holtec International is limited on a "need to know" basis.

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

(8) The information classified as proprietary was developed and compiled by Holtec International at a significant cost to Holtec International. This information is classified as proprietary because it contains detailed descriptions of analytical approaches and methodologies not available elsewhere. This information would provide other parties, including competitors, with information from Holtec International's technical database and the results of evaluations performed by Holtec International. A substantial effort has been expended by Holtec International to develop this information. Release of this information would improve a competitor's position because it would enable Holtec's competitor to copy our technology and offer it for sale in competition with our company, causing us financial injury.

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

The research, development, engineering, and analytical costs comprise a substantial investment of time and money by Holtec International.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

Holtec International's competitive advantage will be lost if its competitors are able to use the results of the Holtec International experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

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

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STATE OF NEW JERSEY)
) ss:
COUNTY OF BURLINGTON)

Debabrata (Debu) Mitra-Majumdar, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of her knowledge, information, and belief.

Executed at Marlton, New Jersey, this 15th day of May, 2013.

Debabrata (Debu) Mitra-Majumdar, Ph.D.
Holtec International

Subscribed and sworn before me this 15th day of May, 2013.

MARIA C. MASSI
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires April 25, 2015