Exelon Generation.

4300 Winfield Road
Warrenville, IL 60555

630 657 2000 Office

Proprietary Information – Withhold From Public Disclosure Under 10 CFR 2.390

RS-14-100

April 7, 2014

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: Additional Information Regarding License Amendment Request Associated with Use of Neutron Absorbing Inserts in Spent Fuel Pool Storage Racks

References:

1. Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "License Amendment Request – Use of Neutron Absorbing Inserts in Units 1 and 2 Spent Fuel Pool Storage Racks," dated July 16, 2013
2. Email from B. Mozafari (U.S. NRC) to K. Nicely (Exelon Generation Company, LLC), "Request for Additional Information for Use of Neutron Absorbing Inserts in Spent Fuel Pool Storage Racks (TAC Nos. MF2489 and MF2490)," dated February 28, 2014 (ADAMS Accession No. ML14059A156)
3. Email from B. Mozafari (U.S. NRC) to K. Nicely (Exelon Generation Company, LLC), "Fw: Draft Request for Additional Information for Use of Neutron Absorbing Inserts in Spent Fuel Pool Storage Racks (TAC Nos. MF2489 and MF2490)," dated February 24, 2014 (ADAMS Accession No. ML14066A135)
4. Email from B. Mozafari (U.S. NRC) to K. Nicely (Exelon Generation Company, LLC), "Draft RAI from TAC Nos.: MF2489 and MF2490 Review on Neutron Absorbing Inserts," dated February 24, 2014 (ADAMS Accession No. ML14066A136)

In Reference 1, Exelon Generation Company, LLC (EGC) requested a license amendment 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 was requested due to the degradation of the Boraflex neutron absorbing material, currently being used in the QCNPS SFPs.

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Attachments 2 and 3 Contain Proprietary Information. Withhold From Public Disclosure Under 10 CFR 2.390. When separated from Attachments 2 and 3, this document is decontrolled.

The NRC requested additional information that is needed to complete the safety evaluation in References 2, 3, and 4. In response to these requests, EGC is providing the attached information.

Attachments 2 and 3 contain information proprietary to Holtec International, and are supported by an affidavit signed by Holtec International. The affidavit, provided in Attachment 4, 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 requested that the information be withheld from public disclosure in accordance with 10 CFR 2.390. Non-proprietary versions of Attachments 2 and 3 are provided in Attachments 5 and 6, respectively.

EGC has reviewed the information supporting a finding of no significant hazards consideration, and the environmental consideration, that were previously provided to the NRC in Attachment 1 of Reference 1. The additional information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. In addition, the additional information provided in this submittal does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Kenneth M. Nicely at (630) 657-2803.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 7th day of April 2014.

Respectfully,

Patrick R. Simpson
Manager – Licensing

Attachments:
1. Response to Request for Additional Information
2. Holtec International Document RRTI-2127-001R0, "Holtec Responses to Request for Additional Information for Quad Cities Criticality Insert Analysis" (PROPRIETARY INFORMATION)
3. Holtec International Report No. HI-2125245, Revision 5, "Licensing Report for Quad Cities Criticality Analysis for Inserts" (PROPRIETARY INFORMATION)
4. Holtec International Affidavit
5. Holtec International Document RRTI-2127-001R0, "Holtec Responses to Request for Additional Information for Quad Cities Criticality Insert Analysis" (Non-Proprietary Version)
6. Holtec International Report No. HI-2125245, Revision 5, "Licensing Report for Quad Cities Criticality Analysis for Inserts – Non Proprietary Version"

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station
Illinois Emergency Management Agency – Division of Nuclear Safety

bcc:

NRC Project Manager – NRR – Quad Cities
Director – Licensing West
Manager – Licensing, Quad Cities
Site Vice President – Quad Cities
Regulatory Assurance Manager – Quad Cities
Exelon Document Control Desk Licensing (Hard Copy)
Exelon Document Control Desk Licensing (Electronic Copy)
Barry Campbell – MidAmerican Energy Company (Electronic Copy)
bcampbell@midamerican.com
NRC Coordinator – Quad Cities Nuclear Power Station (Electronic Copy)
SVP Letter File
Reg. Assurance Clerk (copy for record turnover)
Commitment Coordinator – Cantera
Ken Nicely
Mark Wagner
Jeff Dunlap
Rosanne Carmean
Michelle Buehler

ATTACHMENT 1
Response to Request for Additional Information

NRC Request 1-1

Section 3.1.3 of Attachment 1 to the July 16, 2013, letter indicates that following approval and implementation of the rack insert amendment there will be several storage cells that will not be usable for one reason or another. Explain how TS 4.3.3 is being revised to reflect the reduced SFP capacity.

Response

Exelon Generation Company, LLC (EGC) has concluded that a change to Technical Specifications (TS) Section 4.3.3, "Capacity," is not warranted. The following provides the basis for this determination.

The Quad Cities Nuclear Power Station (QCNPS) Unit 1 and Unit 2 spent fuel pools (SFPs) currently contain three rack cell locations (total) that cannot accept a NETCO-SNAP-IN® rack insert. These locations were permanently blocked when it was determined (following initial installation of the high density racks) that interferences prevented storing fuel in these locations. Each cell is blocked with a permanent barrier that prevents fuel storage. To date, no other locations have been identified that cannot receive an insert due to interferences (a final determination cannot be made until project completion).

TS Section 4.3.3 specifies the licensed maximum spent fuel storage pool 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." Since EGC is not proposing to expand the storage capacity, no change to TS Section 4.3.3 is required. Also, the proposed change to TS Section 4.3.1, "Criticality," provides a requirement that storage locations include a neutron absorbing insert ("The installed neutron absorbing rack inserts having a Boron-10 areas density ≥ 0.0116 g/cm^2."). Therefore, any rack cell without an insert would not meet the requirements of TS Section 4.3.1, and could not be used for fuel storage. However, since TS Section 4.3.3 states the <u>maximum</u> limit to no more than the specified number of fuel assemblies permitted to be stored, a reduction in usable locations does not invalidate the maximum storage limitation.

NRC Request 1-2

For the 'Super Lattice' cases there is very little margin to the regulatory limit. Section 3.4.2 of Attachment 1 to the July 16, 2013 letter, discusses mechanical wear of the inserts. While the section indicates that minimal insert mechanical wear is expected the minimum as-built areal density of the inserts is the same value as is being used in the NCS. This means that for the inserts which are installed at the minimum as-built areal densities can tolerate essentially no wear of any kind before the insert no longer has the requisite areal density to perform as analyzed. With that in mind provide the following:

a. Justification of the proposed wear surveillance. NRC staff considers one insert too limited of a sample size and recommends the licensee increase the sample size to three or more. Additionally, the NRC staff considers the licensee's proposed definition of 'high duty' to be limited as it does not appear to consider the potential for a low number of fuel movements having a higher contact with the insert as being more limiting than a high number of fuel moves with essentially no contact with the insert.

b. Discuss whether the process of placing the inserts into the rack results in any wear on the insert.

Response

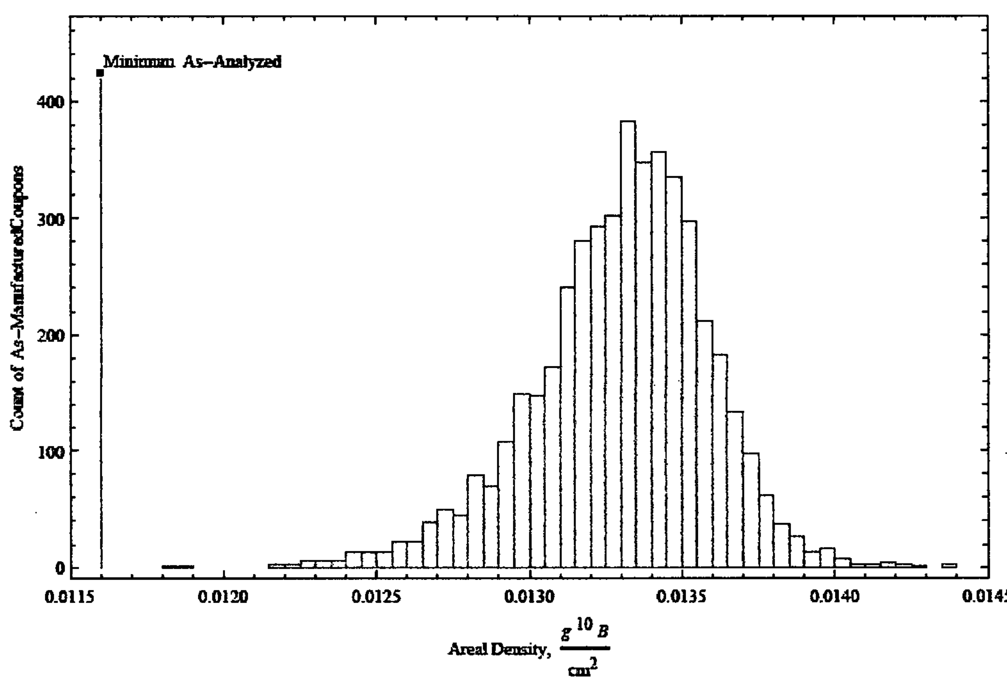
To date, through general observation, there has been no evidence of any uniform mechanical wear on the NETCO-SNAP-IN® inserts at either Peach Bottom Atomic Power Station or LaSalle County Station. If wear were to occur, areal density coupon test results performed for each insert show that significant margin exists to the minimum certified areal density of the inserts.

The histogram below shows the minimum measured areal density values of a quantity of approximately 3,250 test coupons (i.e., one coupon for every sheet, from which two inserts are made) representing inserts manufactured for QCNPS to date.

Minimum measured areal density = Measured areal density – uncertainty

These results are based upon the minimum measured values of the insert coupons that were cut from the same sheet of material as the inserts. This histogram shows that the minimum certified areal density value, which is labeled on the histogram as "Minimum As-Analyzed," is six sigma less than the average minimum measured areal density of the manufactured inserts. This provides considerable margin sufficient to identify wear phenomena that may occur on the inserts before it would affect their intended reactivity hold-down capability.

QCNPS Composite Areal Density Coupon Results
Based Upon Minimum As-Measured Coupon Values



In addition, interference testing was performed during the demonstration testing of the inserts in the SFP. Observations during these tests showed that the fuel bundle reached the bottom of each cell with no apparent interference. Minor contact is more likely to occur when the fuel channel clip aligns the bundle in the rack cell due to the increased fuel channel cross section at that elevation. The fuel channel clip protrudes from the channel making this the widest point. If wear were to occur, this is the most likely location, which is at the top of the insert and above the active fuel region. Therefore, it would not impact the safety function of the insert. In addition, wear in this location would be identified in inspections and will provide an early indication of wear at other locations.

Removal inspections occur once every ten years on high duty cells. These visual inspections will be compared to high resolution digital photos of generic as-manufactured coupons, which are representative for the purposes of pre-characterization. QCNPS will also perform an in-situ visual inspection every two years of two inserts that have been surrounded by freshly discharged fuel after each Unit 1 refueling outage. This activity provides an opportunity to identify potential wear in additional cells.

Given the fact that wear is directly proportional to both sliding distance and force, both a long sliding distance and a high force are of interest. In a high duty cell, fuel bundles are inserted and removed more frequently than other locations such that wear could occur over the length of the insert; therefore, a high duty cell is representative of a long sliding distance. This type of wear is investigated in the removal inspections that occur every ten years. However, a low duty cell with high contact is representative of a high force. Under these conditions, it is more likely to see wear at the point where the fuel bundle is widest. As previously mentioned, this location is where the fuel channel clip protrudes from the channel, which is located at the top of the insert. Wear at this location would not impact the safety function of the insert because it is above the active fuel region; therefore, inspections are not required for high contact low duty cells.

Due to imperfections of the rack cells, scratching and/or gouging may occur during insert installation. General observations made during testing showed that when these indications occur, they are in the corners of the insert since these are the areas where contact is initially made between the insert and the rack cell during insert installation. Scratching in these areas results in a negligible change to the overall performance of the insert. Furthermore, the inserts have margin to the minimum certified areal density as described above.

In addition, the super lattices have been removed from the criticality analysis. This results in significantly more margin to the regulatory limit, as described in response to NRC Request 1-15 in Attachment 2; therefore, margin could be credited as warranted in the unlikely event that wear were to occur.

NRC Request 1-3

Sections 3.9.3 and 3.9.4.2 of Attachment 1 to the July 16, 2013, letter discusses the long term surveillance program for the inserts. The specified acceptance criterion for Boron-10 (^{10}B) areal density is 0.0116 gm/cm^2. This is the minimum as-built/minimum certified areal density for the entire population of inserts. A coupon or insert could experience degradation and pass this acceptance criterion if its as-built areal density was above 0.0116 gm/cm^2. Explain how the surveillance program guarantees that any degradation is detected before it affects the safety function of the inserts installed in the SFP.

Response

As stated in the response to NRC Request 1-2, significant margin exists to the minimum certified areal density of the inserts.

The surveillance program provides additional measures of material performance beyond neutron attenuation testing. These methods include measuring the thickness of the coupons in predetermined locations, measuring overall dimensions of the coupon, visual inspection, high resolution photography, and performing optical microscopy. Criteria for these tests are intended to identify any changes in material properties early.

The acceptance criterion for areal density is intended to reflect the absolute limit, and any changes that are identified will be evaluated in accordance with the Corrective Action Program.

Given the margin to the minimum certified areal density, the interval between testing of surveillance coupons is short enough to detect possible loss of material before the safety function of the insert is affected.

NRC Request 1-4

Section 2.3.1.1 of HI-2125245 Revision 4 mentions MOX fuel. Provide a description of the MOX fuel assemblies stored in the Quad Cities SFPs. Provide the justification of how the HI-2125245 analysis bounds those MOX fuel assemblies, include descriptions of the analysis that was performed in support of the justification.

Response

Response is provided in Attachment 2.

NRC Request 1-5

Section 2.3.1.1.2 of HI-2125245, Revision 2 discusses the isotopic compositions used in the analysis. The text implies the analysis is modeling a number of short lived isotopes and volatile and gaseous isotopes not explicitly mentioned in the discussion of the analysis assumptions. Provide a justification for using these short lived, volatile, and gaseous isotopes as well.

Response

Response is provided in Attachment 2.

NRC Request 1-6

Section 2.3.5.4 of HI-2125245, Revision 2 discusses the various fuel orientations within the storage cells that were considered. The report also indicates fuel assemblies at Quad Cities will have radial gradients based on actual fuel pin loading and rodded operation. It is not clear from Section 2.3.5.4 that the fuel orientations considered included the case where the most reactive quadrant of the fuel assemblies were all turned toward each other. Was this case considered in Section 2.3.5.4, and if so identify the case.

Response

Response is provided in Attachment 2.

NRC Request 1-7

HI-2125245, Revision 2 discusses the effect of fuel channel bulging and bowing. This section indicates the reactivity effect is bounded by abnormal/accident scenarios. The presence of fuel channel bulging and bowing would be part of the normal condition of the SFP storage system and needs to be included in the estimation of reactivity under normal conditions. The NRC staff considers it inappropriate to use accident conditions to bound normal operating conditions, especially when the normal operating conditions would be the starting point for subsequent abnormal/accident scenarios. Revise the NCS to account for fuel channel bulging and bowing under normal conditions.

Response

Response is provided in Attachment 2.

NRC Request 1-8

HI-2125245, Revision 2 discusses the normal conditions of fuel movements, inspections, and reconstitution operations. This section indicates the reactivity effect is bounded by abnormal/accident scenarios. It is not appropriate to use accident conditions to bound normal operating conditions. Revise the NCS to account for these normal operations, or clarify how those type of normal operations cannot occur coincident with abnormal/accident conditions. If abnormal/accident conditions can occur (dropped assembly) during normal operation they should also be considered in the accident analysis.

Response

HI-2125245 Revision 2 and Revision 4 discuss normal conditions of fuel movements, inspections and reconstitution operations in Section 2.5. The discussion regarding fuel movement, inspection and reconstitution operations is related to possible accident configurations and how they bound any normal non-accident configuration. The normal conditions are not being dismissed as irrelevant; rather, it is well understood that normal operations such as fuel movement, inspection or reconstitution is a low reactivity configuration because of its distance from any other fuel. The normal operations for the fuel in the SFP have been completely evaluated from the moment the fuel enters the pool until the fuel enters the reactor. There are no normal conditions that exist in which the fuel is within close proximity to another fuel assembly that have not been explicitly considered in the analysis and will be discussed further below.

Fuel movement procedures govern the movement and inspection of the fuel at all times that the fuel is onsite. The fuel enters the SFP via the fuel prep machine (FPM). The FPM has a single fuel assembly capacity. There are two FPMs in each SFP, which could be loaded with fuel at the same time. However, the FPMs are greater than nine feet apart, which is a low reactivity configuration because of the distance between either FPM so no further analysis beyond the normal condition is necessary. The fuel is then picked up by the refueling platform, which also has a single fuel assembly capacity at any given time, and moved into a storage location in the storage rack. From the storage rack, the fuel is picked up by the refueling platform and moved through the refueling slot for transport to the core. The return trip uses the same process in reverse. All of these fuel movement operations involve a single fuel assembly that is never in close enough (i.e., directly adjacent) proximity to any other fuel that the configuration is not bounded by the analysis for normal conditions.

The FPM is not considered to be a long-term storage location for fuel but it is physically possible that a fuel assembly in the FPM could be approached by another fuel assembly in the refueling platform. The FPM is only single capacity; therefore, once a fuel assembly is in the FPM there is no normal operation that would allow the presence of another fuel assembly in close proximity to the FPM. This configuration (i.e., two fuel bundles in or around a FPM) is not considered a normal configuration, but if normal operations resulted in this configuration, it would be bounded by the mislocation of a fuel assembly between the SFP rack and the inspection platform, which is discussed in Section 2.6.6.3 of HI-2125245, Revision 2 and Revision 4. That is to say that this normal configuration is bounded by the accident scenario because there is no further possible accident from this normal initial condition that makes it any worse than the accident scenario already analyzed. Due to the location of the FPM, only one of the two refueling platforms can ever physically use the FPM at any given time. Furthermore, dimensions for distance from the FPMs to the nearest SFP rack is 4.125 inches, which is less than the dimensions of a fuel assembly, so it is not feasible to have a normal configuration that results in more than two fuel assemblies adjacent in the FPM and refueling platform.

Since the Unit 1 and Unit 2 SFPs are adjacent to each other and connected, it is possible that both refueling platforms could be in either pool and in operation moving fuel at the same time. However, even at the closest approach of the two cranes, the fuel being moved by the refueling platforms cannot ever come physically close enough to be considered adjacent. Therefore, for the same reasons discussed above, there is no normal fuel movement operation that ever brings two fuel assemblies close enough to be considered adjacent that would result in an initial normal configuration that would lead to a worse accident scenario not bounded by the analysis.

The consideration of fuel movement, inspection and reconstitution has been thoroughly evaluated. There is no normal initial configuration that would lead to a worse accident scenario not already explicitly considered by the analysis due to physical space limitations and equipment configurations.

NRC Request 1-9

Section 2.6.7 of HI-2125245, Revision 2 discusses an incorrect orientation of an insert. If an incorrect orientation of an insert is accepted as-is following installation, then that orientation becomes the normal as-built configuration. With respect to incorrect orientation of an insert, provide post-installation measures that will be taken to verify that all inserts are orientated correctly.

Response

The orientation of the rack inserts is controlled by station procedure QCFHP 0400-28, "NETCO SNAP-IN Spent Fuel Rack Insert Installation and Removal." Step 4.2.4 and 4.2.4.1 of Revision 3 of QCFHP 0400-28 state: "**ORIENT** the installation tool **and** "V" bend of the insert to the SOUTHWEST. **PERFORM** a peer check to verify proper orientation." Per this procedure, an insert would not be accepted as-is in an incorrect orientation. Documentation of the verification is completed using Attachment 1 of procedure QCFHP 0400-28 or Attachment 5 of procedure NF-AA-309, "Special Nuclear material and Core Component Move Sheet Development."

NRC Request 1-10

The inserts are required to function and remain in place under design operational and accident conditions. Explain how the inserts will perform under required accident conditions (e.g., seismic event, dropped assembly, and heat up events, if applicable) and provide a basis for the conclusions.

Response

The response to NRC Request 2-1 addresses the performance of the inserts during a design basis seismic event. It shows that the inserts are qualified for the SSE condition.

In the case of a dropped assembly, the inserts themselves are an integral part of the high density fuel racks; impact from fuel assembly/cell collision has been previously considered and determined to not impact the design function. Any damage that would occur to the insert would be above the active fuel region; therefore, the insert will still be able to perform its design function.

If a heat up event were to occur in the SFP, it would not affect the criticality hold down ability of the inserts. Temperatures during a heat up event are not high enough to permit distortion of the insert's shape. The saturation temperature at the bottom of the SFP is 252°F (122°C). This value was determined from a pool depth of 37 feet 9 inches and a conservative weight density of water at 40°F. This is a significantly lower temperature than the temperature (i.e., 350°C - 450°C) for the annealing process during the manufacturing of the inserts. The only effect this may have on the inserts would be in the retention force of the material. However, even if a loss of retention force did occur, it has been shown in the response to NRC Request 2-1 that retention force is not required to prevent insert displacement during a design basis seismic event. Therefore, the safety function of the insert would not be affected.

NRC Request 1-11

Section 2.9 of HI-2125245, Revision 2 discusses reconstituted fuel assemblies. With respect to reconstituted fuel, provide the following information:

a. The text indicates that the current inventory of reconstituted fuel at QCNPS had fuel rods replaced with either like for like fuel rods or stainless steel. The analysis concludes there was no increase in reactivity for these legacy reconstituted fuel assemblies. Justify the basis for that conclusion.

b. The text indicates that future reconstitutions will only use stainless steel pins. Elsewhere in the analysis it is indicated that the Optima2 fuel assembly is under moderated. Replacing a fuel rod with a stainless steel pin reduces the amount of under moderation. This potential increase in reactivity may be offset by the additional neutron absorption in the stainless steel pin. Describe any limitations on the number or material of the stainless steel pins. Explain how did those conclusions were reached.

Response

Response is provided in Attachment 2.

NRC Request 1-12

HI-2125245, Revision 2 includes the results of numerous cases that were run to support the determination of the bounding lattice used in the analysis. However, from the information provided it is unclear to the NRC staff what the particular details of each case are and how they relate to current QCNPS fuel.

Response

Response is provided in Attachment 2.

NRC Request 1-13

Section 2.3.1.4 of HI-2125245, Revision 2 discusses a series of calculations performed to demonstrate that certain simplifications in the SVEA-96 Optima2 fuel geometry as modeled in CASMO-4 (due to code limitations) do not have a significant impact on the calculated rack k-infinity. The calculations were performed based on a single fuel lattice. Provide the technical basis for concluding that this finding of no significant impact will apply broadly to all expected lattices (i.e., lattices with different compositions, gadolinia loading, and locations of gadolinia pins).

Response

Response is provided in Attachment 2.

NRC Request 1-14

Section 2.3.4.1 of HI-2125245, Revision 2 addresses fuel manufacturing tolerance biases for the SVEA-96 Optima2 fuel assembly. However, the tolerances associated with other fuel lattice types are not addressed. Provide a statement explaining why any potential increase in fuel manufacturing tolerance bias for a different fuel assembly design are not expected to be larger than the reactivity difference between the limiting lattice(s) for that fuel assembly design compared to the limiting SVEA-96 Optima2 lattice.

Response

Response is provided in Attachment 2.

NRC Request 1-15

Revision 4 of HI-2125245 removed part of Section 2.7 as included in Revision 2, which discussed a new approach in which super-lattices could be used to qualify future lattices. However, superlattices are still used in the analyses. Given that the super lattices result in significantly less margin to the regulatory limit, please indicate if the proposed revision to the current licensing basis of Quad Cities is to be based on the design basis lattice, or on the super lattices. Provide clarification.

Response

Response is provided in Attachment 2.

NRC Request 1-16

Provide more detail for the technical basis and assumptions inherent in the criteria described in HI-2125245, Revision 2 to select lattices for evaluation using the in-rack k-infinity calculational method. In particular, explain why more lattices were not selected for evaluation and why it is appropriate to conclude that the most limiting in-rack k-infinity will be found among the candidate lattices.

Response

Response is provided in Attachment 2.

NRC Request 1-17

CASMO-4 is used to perform depletion calculations which provide the isotopic compositions used as inputs to the MCNP5-1.51 NCS analyses. Describe how CASMO-4 is qualified for performing depletion calculations with the SVEA-96 Optima2 fuel assembly; given that a different code is used for NRC-approved reload analysis methods. Address the fact that the documented CASMO-4 k-infinity values show a persistent bias relative to MCNP5-1.51 results for the same fuel lattices. If CASMO-4 is not formally qualified for this purpose, then explain why use of the 5% depletion uncertainty described in DSS-ISG-2010-01 remains applicable.

Response

Response is provided in Attachment 2.

NRC Request 1-18

The screening calculations performed as reported in HI-2125245, Revision 2 assumes "nominal" operating conditions. After the design basis lattice is selected, then different operating conditions are investigated to establish a limiting set of "design basis" operating condition. Provide the technical basis for concluding that the limiting operating conditions used as input to the NCS analyses are solely a consequence of the fuel assembly geometry and/or fuel assembly design specific characteristics. In other words, if the "design basis" operating conditions differs for different fuel assembly designs, Explain how this changes the lattice(s) selected as a result of the screening calculations.

Response

Response is provided in Attachment 2.

NRC Request 1-19

Control rod specifications are given in HI-2125245, Revision 2. Section 7.1.4 indicates that operation with the adjacent control rod inserted is one of the core operating parameters that has a significant impact on the NCS analysis. Many BWR plants have had to replace installed control rods due to tip cracking and/or B-10 depletion. Identify if other types of control rods are currently used at Quad Cities, and if so, provide a justification for the assumption that the control rod specifications used bound all other control rod types in use at Quad Cities for the depletion parameters used as input in determination of the isotopic compositions for the NCS analyses.

Response

HI-2125245, Revision 2 and Revision 4, Table 5.2(b) provide the reactor control blade data for the original equipment manufacturer (OEM) control blade, also known as DuraLife 100 (D-100) manufactured by General Electric (GE). This design is no longer available and has since been replaced with updated designs. When a new control blade is introduced, it must be accepted per the EGC configuration control process. As part of that process, it is confirmed that the replacement control blade meets all design specifications and functions. The control blades must be mechanically compatible with the reactor and rod drive components and must fit in the core, which has a fixed physical geometry for the control blades. Therefore, design specifications of various control blade types are similar if not identical to the OEM control blades. The advance control blade designs are also considered a match in reactivity worth to the OEM control blade design, which means that the reactivity is within +/-5% of the original equipment control blades design and thus no additional considerations need to be applied in core design or analysis. Control blades are essentially "black" to neutrons and since all control blades are designed to a specified reactivity band, the results on the fuel when controlled during in-core depletion and then put into a rack environment are not impacted by the type of blade. The OEM is an acceptable approximation for all QCNPS control blade designs for these reasons.

NRC Request 1-20

Section 2.2.2 of HI-2125245, Revision 2 indicates that a validation of CASMO-4 to determine a bias and bias uncertainty is not necessary because CASMO-4 is not being used for the design basis k-eff calculations. CASMO-4 is being used to screen out lattices in order to limit the number of MCNP5-1.51 calculations that need to be performed. The underlying assumption is that any bias between CASMO-4 and MCNP5-1.51 results will tend to be consistent, so the relative values for CASMO-4 can be used to identify the most reactive lattices. Provide support for the assumption that the most reactive lattice determined by CASMO-4 will produce the maximum in-rack reactivity using MCNP5-1.51.

Response

Response is provided in Attachment 2.

NRC Request 1-21

HI-2104790, Revision 1 provides a detailed description of the benchmarking of MCNP5-1.51, trend analysis, and statistical analysis as discussed in NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," issued January 2001. It is not clear how the critical benchmarks and experiments bound the Area Of Applicability (AOA) for the fuel lattices being studied with respect to specific characteristics of the geometry of the SVEA-96 Optima2 lattice. Provide a discussion of how the AOA is adequately bounded for the specific characteristics of the SVEA-96 Optima2 fuel lattice.

Response

Response is provided in Attachment 2.

NRC Request 2-1

Section 3.4.4 of Evaluation of Proposed Changes (Attachment 1 of the Reference) indicates that the 41.5 lbf (pound-force) retention force is adequate to maintain the inserts in their required position under the Safe Shutdown Earthquake (SSE) conditions based on seismic accelerations present at the QCNPS location. Since the QCNPS design basis seismic event has a vertical acceleration less than 1.0g; the licensee has noted that the reduction in retention force due to stress relaxation is acceptable. Please provide the calculation and/or analysis that support the determination that the stress relaxation is acceptable.

Response

A summary of the applicable sections of the seismic calculation that supports the determination that the stress relaxation is acceptable is provided below. QCNPS has a peak vertical acceleration of less than 1.0g. Using this value to perform the calculation for the SSE seismic load shows an uplift force that is less than the weight of the inserts. The calculation determines that retention force is not required during a seismic event to prevent the insert from moving in a vertical direction. The weight of the insert itself is enough to prevent this from occurring. Therefore, a conservative stress relaxation rate of 58.5% over 20 years in the insert material, assuming a minimum retention force of 100 lbf during insert installation, is acceptable with regards to satisfying the SSE conditions simply because the weight of the insert alone satisfies this condition.

The analysis uses the conservative static coefficient method. Under this method the peak acceleration (PA) is multiplied by the static coefficient factor of 1.5 to take into account the effects of both multi-frequency excitation and multimode response. The dead weight (DW) of the insert is multiplied by the SSE acceleration and static coefficient factor.

The vertical seismic design spectra for QCNPS Units 1 and 2 were taken as a constant value of 0.08g for operating basis earthquakes (OBEs) and 0.16g for SSEs based on the design basis calculation that determined the seismic design criteria for the QCNPS Units 1 and 2 Reactor and Turbine buildings.

$$SSE_{acc} = PA = 0.16g$$

Peak loads in the (+) vertical direction for faulted (SSE) vertical load is calculated as follows:

$$SSE_{load} = (1.5 * PA * DW) - DW$$

$$SSE_{load} = (1.5 * 0.16g * 16.83lbs) - 16.83lbs \qquad SSE_{load} = -12.791lbf$$

The following table shows the weights and SSE_{load} results for each of the NETCO-SNAP-IN® insert designs.

Component Weights (Neglecting Buoyant Forces) and Calculated SSE_{load} Results		
Insert Part No.	**Weight (lbs)**	**SSE_{load} (lbf)**
NSI-QC1-A17-01	16.83	-12.791
NSI-QC1-A17-04	16.27	-12.365
NSI-QC1-A17-05	16.22	-12.327
NSI-QC1-A17-06	16.32	-12.403

Due to the fact that the calculated SSE_{load} is below 0 for every insert design, it can be concluded that during an SSE seismic event, there is insufficient seismic acceleration to cause the NETCO-SNAP-IN® insert to come up and out of the spent fuel storage rack.

NRC Request 2-2

Section 3.5 of Evaluation of Proposed Changes of the Reference indicates that the test results from the demonstration program, noted in the LAR, 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. The inserts are considered to be integral with the spent fuel pool (SFP) storage racks. These statements in Section 3.5 of Attachment 1 appear to contradict with the information provided in Sect 3.4.4 of Attachment 1 of the Reference, as noted in the RAI above. Please provide an explanation for this apparent contradiction.

Response

As shown in the response to NRC Request 2-1, retention force is not required to satisfy the SSE conditions. The weight of the inserts alone is enough to prevent them from displacing during a design basis seismic event. However, some retention force is still utilized to prevent the insert from displacing during normal plant operations. A value of 100 lbf was chosen as a minimum retention force requirement during the installation of the inserts to prevent the displacement of the inserts during normal operations.

As stated in Table 3.9-7 of Attachment 1 of Reference 1, the acceptance criterion for retention force of a surveillance insert is a minimum of 50 lbf. As stated in section 3.4.3 of Attachment 1, during demonstration testing, maximum drag force observed during bundle withdrawal was significantly less than 50 lbf. As stated in Table 3.9-4 of Attachment 1, the acceptance criterion for stress relaxation of the insert material is a 50% reduction over 20 years. Because of these two acceptance criteria, a retention force of 100 lbf was chosen as the minimum allowable value during the initial installation of the inserts. If the stress relaxation criterion is met, the retention force of any insert that remains in the spent fuel pool will not drop below the required 50 lbf value for preventing displacement during normal operations. However, if an insert was to have less than 50 lbf of retention force, the insert will still meet the neutron absorption requirements since it will remain in place during SSE conditions. Having a low retention force may result in displacements during normal operations. Displacements are addressed in station procedures to ensure that fuel remains in an analyzed configuration for criticality.

NRC Request 2-3

Section 9.1.2.3 "Safety Evaluation," of the QCNPS Updated Final Safety Analysis Report (UFSAR) states, in part, that, "For the mechanical design of the spent fuel modules, two sets of criteria have been evaluated. The first established requirements to ensure that adjacent racks will not impact during the safe shutdown earthquake (SSE), assuming the lower bound value of the pool surface friction coefficient. This criterion required that a safety factor against tilting be 1.5 for the operating basis earthquake (OBE) and 1.1 for the SSE. The second set of criteria established requirements to ensure that loading combinations and stress allowables are in accordance with Section III, Subsection NF, of the American Society of Mechanical Engineering (ASME) 1980 Edition." Provide information confirming that all applicable design basis requirements applicable to the existing QCNPS SFP racks, as stipulated by the provisions of Subsection NF of the ASME Code, will remain satisfied following installation of the neutron absorbing inserts. Specifically, confirm that normal and abnormal operating condition loads, including deadweight, thermal and seismic loads, are bounded by those used in the existing analysis of record such that the resulting margins of safety are positive and will continue to satisfy the requirements of the ASME Code.

Response

The spent fuel pool racks in their inception were analyzed with stress limits in accordance with ASME Section III, Subsection NF, 1980 Edition. Load cases which include the combination of deadweight, thermal and seismic were analyzed for both normal operating and abnormal conditions. Additionally, the spent fuel pool racks were analyzed for displacement and tipping.

The installation of the inserts superimposed a new load onto the spent fuel pool racks. The spent fuel pool racks have been analyzed for this condition, and the results of this analysis confirmed that the spent fuel pool racks remain within the stress limits established in ASME Section III, Subsection NF, 1980 Edition for both normal operating and abnormal conditions. Additionally, the analysis confirmed that the revised displacements and tipping are well within the original acceptance criteria.

With the inserts installed, the resulting maximum stress ratio is 86% of allowable.

With the inserts installed, the resulting maximum displacement and tipping ratio is 1.537 inches compared to an allowable of 2.375 inches.

NRC Request 3-1

On page 23 of the July 16, 2013 submittal, it states "The surveillance "trees" were placed within one of the QCNPS SFPS..." Since SFP conditions in each Unit could be different, identify in which Unit's SFP are the "trees" placed and whether the placement is considered bounding for both pools. Discuss why placement of coupons in one pool will ensure adequate material surveillance representing all panels.

Response

The surveillance coupon trees were placed in the Unit 1 SFP. The surveillance trees are treated similarly to the inserts used for in-situ inspections described in Reference 1, Attachment 1, Section 3.9.4.1.

To consider this location bounding for both pools, it is important for the coupons to match or exceed the most severe environment expected for the 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. The surveillance assemblies have been placed in a location that is to be surrounded by freshly discharged fuel after each Unit 1 refueling outage beginning with the spring 2013 refueling outage (i.e., Q1R22). This will maximize the thermal load and radiation exposure received from freshly discharged fuel so that the radiation effects will bound all other inserts in either pool. Two rack cells have been designated as test locations so that freshly discharged fuel can surround the surveillance trees. The proposed strategy will not adversely impact B.5.b fuel pool loading requirements. As described in Reference 1, Attachment 1, Section 3.9.4.1, placement of the highest exposed discharged fuel in the cells surrounding the test locations will be administratively controlled. The intent of this statement is that fuel most recently discharged from an operating reactor will be placed in the eight cells surrounding each of the surveillance coupon trees. This will ensure the test locations remain bounding with respect to maximized radiation effects relative to the rest of the insert locations in the pool.

In addition to maintaining the bounding condition with respect to radiation exposure, the rack cell location chosen for the surveillance trees must be appropriate with respect to water chemistry and temperature. As noted in Reference 1, Attachment 1, Section 4.1, the Unit 1 and Unit 2 pools are connected by a double-gated transfer canal. The pools are normally connected permitting mixing between pools as well as the ability to remain connected for redundancy and reliability. Reference 1, Attachment 1, Section 3.9.4.1 states, "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." Therefore, placement of coupons in the Unit 1 pool is representative of the Unit 2 pool.

NRC Request 3-2

On page 26 of the July 16, 2013 submittal, it states "Two rack inserts from the Unit 1 SFP will be visually inspected." Discuss and justify whether inserts from Unit 2 will be visually inspected. If the inserts in Unit 1 are the only ones to be visually inspected, please discuss why a Unit 2 inspection is not necessary.

Response

Two rack inserts from the Unit 1 SFP will be visually inspected. The same discussion presented in NRC Response 3-1 is applicable in NRC Response 3-2. Reference 1, Attachment 1, Section 3.9.4.1 discusses that the in-situ inserts will be those with maximized radiation exposure from freshly discharged fuel so that the radiation effects will bound all other inserts in the pool. The Unit 1 and Unit 2 pools are connected permitting mixing between pools. Section 3.9.4.1 also discusses there is not a worst case scenario or bounding rack cell location associated with water chemistry and temperature. In-situ inserts placed in the Unit 1 pool are representative of the Unit 2 pool given the bounding radiation effects of fuel and consistent water chemistry and temperature; therefore, it is acceptable to only inspect the in-situ inserts from the Unit 1 pool.

NRC Request 3-3

In NET-300054-01 Rev 0, the visual inspection of the coupons revealed some rust colored pitting.

a. For coupons F15 and F16, discuss the cause of this pitting. Include whether the pitting is indicative of what the SFP inserts may be experiencing.

b. For coupon F11, discuss whether the carbon steel tool chain was the cause of the large pit. If not, discuss the cause of the large pit.

Response

In coupons F15 and F16, the cause of the pitting appears to be iron contamination of the coupon. This has been observed in other coupon examinations and is likely due to an inclusion of iron from the rolling mill or other tooling source during manufacturing. Where this has been observed, the most severe cases have led to pitting in the area of the coupon immediately adjacent to the contamination. The generation of iron inclusions can be a consequence of the rolling process. The material qualification test (i.e., NETCO Report NET-259-03, "Material Qualification of Alcan Composite for Spent Fuel Storage," which was submitted to the NRC as Attachment 8 of Reference 1) identified corrosion products on the coupons, which included corrosion due to iron contamination. Given the satisfactory performance of these coupons in the material qualification test report, and the lack of any noticeable change in attenuation, there is confidence that the fast start coupon results are bounded by the accelerated corrosion performance results of the material qualification report. The tests performed as part of the proposed surveillance program will provide the opportunity for the test engineers to identify any further issues with iron inclusion and take appropriate measures to identify whether it is having a significant impact on the performance of the neutron absorber material.

It is not known whether a carbon steel tool chain or other iron based contaminant is responsible for the defect observed in coupon F11. It is possible that the iron contaminant was rolled into the material during the fabrication process and was not observed during the pre-characterization process.

For all 3 coupons mentioned, the pitting appears to be a consequence of external contamination of the coupon. To the extent that this may apply to the inserts, it may lead to small, localized galvanic corrosion near the contaminant. In past examinations, this has led to pitting in the area of the coupon immediately adjacent to the contamination. In tests where iron-based corrosion products have been observed (e.g., NETCO Report NET-259-03), neutron attenuation testing has not shown any noticeable reduction in the areal density of the test coupons.

References

1. Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "License Amendment Request – Use of Neutron Absorbing Inserts in Units 1 and 2 Spent Fuel Pool Storage Racks," dated July 16, 2013

ATTACHMENT 4

Holtec International Affidavit

U.S. Nuclear Regulatory Commission
Document ID 2127006
Non-Proprietary Enclosure 1

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 5 (Proprietary Version).

b. RRTI-2127-001R0, "Response to Request for Additional Information", Quad Cities, RAI (proprietary information).

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).

AFFIDAVIT PURSUANT TO 10 CFR 2.390

(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.

AFFIDAVIT PURSUANT TO 10 CFR 2.390

(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.

AFFIDAVIT PURSUANT TO 10 CFR 2.390

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 27th day of March, 2014.

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

Subscribed and sworn before me this 27th day of March, 2014.

Carl P. DeCurtis, Esq. NJ Attorney License Number 000412008
"An Attorney-At-Law of the State of New Jersey authorized to administer this oath pursuant to N.J.S.A. 41:2-1."