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

December 20, 2017

Ms. Tanya M. Hamilton
Site Vice President
Shearon Harris Nuclear Power Plant
5413 Shearon Harris Road
M/C HNP01
New Hill, NC 27562-0165

SUBJECT: SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1 – REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST FOR SPENT FUEL STORAGE POOL CRITICALITY ANALYSES (CAC NO. MF9996; EPID L-2017-LLA-0303)

Dear Ms. Hamilton:

By application dated June 28, 2017 (Agencywide Documents Access and Management System Accession No. ML17193B165), Duke Energy Progress, LLC (the licensee) submitted a license amendment request for the Shearon Harris Nuclear Power Plant, Unit 1, regarding spent fuel storage pool criticality analyses. The U.S. Nuclear Regulatory Commission staff has determined that additional information is needed in order to complete its review. The enclosed request for additional information was e-mailed to the licensee in draft form on November 21, 2017, and a clarification call was held on November 30, 2017. During the clarification call, a response date of January 18, 2018, was agreed upon. Please note that if a response to this letter is not received by this date, or an acceptable alternate date is not provided in writing, we may deny the application for amendment under the provisions of Title 10 of the *Code of Federal Regulations* Section 2.108, "Denial of application for failure to supply information."

If you have any questions, please contact me at 301-415-2760 or by e-mail to Martha.Barillas@nrc.gov.

Sincerely,

Martha Barillas, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-400

Enclosure:
Request for Additional Information

cc w/enclosure: Listserv

DUKE ENERGY PROGRESS, LLC

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1

DOCKET NUMBER 50-400

REQUEST FOR ADDITIONAL INFORMATION

REGARDING A LICENSE AMENDMENT REQUEST FOR

SPENT FUEL STORAGE POOL CRITICALITY ANALYSES

CAC NUMBER MF9996; EPID L-2017-LLA-0303

By application dated June 28, 2017 (Agencywide Documents Access and Management System Accession No. ML17193B165), Duke Energy Progress, LLC (the licensee) submitted a license amendment request (LAR) for the Shearon Harris Nuclear Power Plant, Unit 1 (HNP), regarding spent fuel storage pool criticality analyses. The U.S. Nuclear Regulatory Commission (NRC) staff determined the following request for additional information (RAI) is needed in order to complete its review.

RAI 1

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.90, "Application for amendment of license, construction permit, or early site permit," states that a LAR must fully describe the changes desired. The LAR proposes changes to TS 5.6.1.3, "BWR [Boiling-Water Reactor] Storage Racks in Pools 'A' and 'B' at HNP," to credit the use of Metamic neutron absorbing rack inserts proposed to be installed in the BWR Boraflex storage rack cells in spent fuel pools (SFPs) A and B, in combination with the soluble boron present in the pools as a replacement for the neutron absorbing properties of the Boraflex panels.

The governing NRC staff regulatory requirements and guidance for design modifications of the SFP and storage racks include, but are not limited to the following: "Office of Technology (OT) Position for Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978 (ADAMS Accession No. ML031280383); NUREG-0800 Standard Review Plan (SRP), Revision 4, dated September 2013 (ADAMS Accession No. ML13198A258), Section 3.8.4, "Other Seismic Category I Structures," including Appendix D, "Technical Position on Spent Fuel Racks," and Section 3.8.5, "Foundations"; American Society of Mechanical Engineers (ASME) Code, Section III, Division 1, Subsection NF; and General Design Criteria 1, 2, and 4 of Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants."

Section 3.5, "Rack Structural Evaluation/Seismic Considerations," of the LAR states that Section 6.0 of Attachment 5, "Holtec International Licensing Report HI-2177590 for Use of Dream Neutron Absorber Inserts in the Spent Fuel Pools 'A' and 'B' at Shearon Harris NPP" (NON-PROPRIETARY), describes the structural evaluation of the HNP SFP racks after DREAM inserts have been added to the existing Westinghouse BWR racks located in Pools A and B. The NRC staff identified that Attachment 5 focuses primarily on a discussion of the weight of the inserts being negligibly small in comparison to the overall dead weight of the SFP racks and pool structures, but does not provide sufficient technical information regarding the seismic analysis and evaluation of the SFP racks and pool structural qualification.

Section 6.1 of Attachment 5 states, in part, that "the effects of the Dream inserts on the structural design bases are evaluated by reviewing the existing analysis reports listed [as in Section 6.7] as References 6.7.1 through 6.7.3." Additionally, Section 6.6 states, in part, that "per the analysis in Reference 6.7.4, Dream inserts are found to be structurally adequate to perform their intended function under both normal and seismic conditions."

The staff requests that the licensee provide References 6.7.1 through 6.7.4, including a complete discussion of the structural analysis and adequacy of the existing SFP racks and pool structure outfitted with Metamic inserts designed to meet the NRC regulatory requirements and guidance discussed above.

The reports should also include discussion of the following: the results of the time-history simulations for the major parameters of interest; applicable loads and loading combinations considered in the seismic analysis of the rack modules consistent with the current design and licensing basis described in the Final Safety Analysis Report; stress levels in the rack modules and their relationship to the ASME III Code, NRC's OT Position Paper and current licensing basis for HNP; the acceptance criteria for stress limits on the rack structure for Level A-D service limits for both Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE) based on ASME III Code, Section III, Division 1, Subsection NF; safety margins against rack overturning for both OBE and SSE load conditions; maximum rack stresses including baseplate-to-pedestal and baseplate-to-rack cell welds; maximum rack displacement and location and discussion of the possibility of rack-to-wall impact between the rack modules; and a description of the analysis used to demonstrate that the existing SFP structure will continue to meet the acceptance criteria considering the presence of Metamic inserts.

<u>RAI 2</u>

In accordance with NRC's OT Position Paper (referenced in RAI 1 above), limiting values of pool water temperatures are discussed in the American National Standards Institute document ANSI-N210-1976, "Design Objectives for Light-Water Reactor Spent Fuel Storage Facilities at Nuclear Power Stations," whereas Section 9.1.3.III.l.d of the NRC SRP is applicable to the maximum heat load with normal cooling systems in operation. The design of the DREAM inserts must ensure that all fuel assemblies in the Westinghouse BWR Spent Fuel Storage Racks (SFSRs) will continue to be adequately cooled by circulation of water for the design-basis scenario. The LAR states in Section 5 of Attachment 5 that increased hydraulic resistance can result in elevated fuel cladding temperature and impact the Time-to-Boil evaluation.

a) Was the increase in hydraulic resistance considered in LAR Subsection 5.4.2, "Time-to-Boil Evaluation," and Subsection 5.5, "Local Water and Fuel Cladding Temperature?"

b) In Subsection 5.5, the Westinghouse BWR SFSRs are modeled as porous medium regions in which Darcy's Law governs fluid flow. Is the porous medium adjusted to account for the increase in hydraulic resistance? In the calculation of the maximum fuel clad temperature, is the hydraulic diameter calculated to consider the presence of the dream inserts?

<u>RAI 3</u>

The applicable 10 CFR 50.68 requirement is that "...[i]f credit is taken for soluble boron, the *k-effective of the* SFSRs loaded with fuel of the maximum fuel assembly reactivity must not

exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water." The licensee submitted a licensing report (Attachments 4 and 5 to the LAR) that included documentation of a criticality analysis performed to demonstrate that this regulatory limit will be met if the proposed Technical Specification (TS) limit on the reactivity for fuel stored in the HNP SFP is satisfied.

a) The Attachment 5 licensing report references Revision 3 of a Holtec report, HI-210490, which provides information on the validation of the criticality code against critical benchmarks and experiments. The NRC has reviewed a previous revision of this validation report, but based on the licensing report, Revision 3 has some new information. Please provide Revision 3 of HI-210490 for the NRC staff to review.

b) A configuration where one Metamic rack insert is missing is included as part of the normal condition for the criticality evaluation. Based on the LAR and the Attachment 5 licensing report, this is because the rack insert must be removed before the fuel assembly can be moved. No further missing Metamic rack inserts are considered as part of the accident conditions. Please describe what controls will be in place at HNP to ensure that no more than one rack insert will be removed from the storage racks in a given SFP, at any time, or discuss the possible configurations that may occur with two or more rack inserts removed from the storage racks in a specific SFP and how this is accounted for.

c) One of the most important parameters affecting the k-effective of the SFP is the reactivity of the fuel assemblies stored therein. The TSs for most BWR licensees are consistent with the standard TSs for BWRs, which includes a control on fuel assembly reactivity, typically via a k-infinity limit or an enrichment limit. Since the fuel being qualified for storage in this LAR is BWR fuel, the criticality controls should be consistent with widely accepted practice for BWR SFPs. The proposed TS language for HNP indirectly controls fuel assembly reactivity by restricting fuel storage to a number of fuel designs known to be less reactive than the design basis assembly used in the criticality evaluation. Please discuss why this indirect control on fuel assembly reactivity can reasonably be expected to meet the same purpose as the more direct language captured in the standard TSs.

Additionally, the staff has identified some instances where it is not clear if the reactivity impact due to specific conditions was adequately addressed in the criticality analysis. The potential reactivity impacts may be positive, so the staff needs additional information to verify the regulatory limit will not be challenged by these potential impacts.

d) The accident scenario identified in the licensing report as being the limiting accident scenario involves a fresh pressurized-water reactor (PWR) fuel assembly mislocated in a way that it is face adjacent to two PWR racks, one BWR rack, and diagonally adjacent to a third PWR rack (i.e., Figure 4.2.6 of the Attachment 5 licensing report). In this scenario, all PWR fuel except for the mislocated fuel assembly are modeled as burned fuel, consistent with the licensed storage configuration that allows unrestricted storage provided that minimum limits on burnup are met. The licensing report also describes a second licensed storage configuration for the PWR racks that consists of a 2-of-4 checkerboard of fresh fuel with empty storage cells. Please discuss whether loading of multiple face adjacent fresh PWR fuel assemblies (including the mislocated fuel

assembly) would be possible, and if so, whether this would result in a higher local reactivity than having all PWR storage cells loaded with spent fuel.

e) The Attachment 5 licensing report explains, in Section 4.2.3.7, that the spent PWR fuel was evaluated at a burnup that leads to an infinite array of PWR storage racks, with the PWR fuel loaded in all cells, yielding the same reactivity as an infinite array of the BWR racks with Metamic rack inserts, fully loaded with the design basis BWR fuel. The intent of doing so was to avoid a calculation in which the calculated k-effective is dominated by the higher reactivity PWR fuel rather than providing any meaningful information about the interface between the PWR and BWR storage racks. The NRC staff understands the intent, but this approach of reducing the reactivity of the PWR fuel relative to the maximum licensed reactivity also has the effect of reducing a potential neutron source adjacent to the BWR fuel. Therefore, the NRC staff requests the following clarifications:

    1. Please describe how much the reactivity of the PWR fuel used in the interface evaluations was reduced relative to the PWR fuel from the design basis criticality calculations for the PWR storage racks, or provide information on the reactivity impact due to the presence of higher reactivity design basis PWR fuel models as a boundary condition to the BWR racks.

    2. Please clarify if the same reduced reactivity spent PWR fuel models were used in the evaluations for the accident conditions. If so, please describe the potential impact on the reactivity calculated for the limiting mislocated fuel assembly scenario due to the use of reduced reactivity spent PWR fuel models.

f) The design basis criticality evaluation documented in the Attachment 5 licensing report includes the assumption of a single missing Metamic rack insert, located in the interior of the design basis BWR storage rack. A missing rack insert could happen in any location, and the licensing report does not appear to address the reactivity impact of configurations in which the missing rack insert occurs in a peripheral location near the interface with the PWR racks, or in a location near the limiting mislocated fuel accident scenario. Please discuss the criticality impact due to the missing rack insert for locations at the periphery of the BWR rack, particularly when the configuration being analyzed does not utilize a repeating infinite array. Please further justify that the previously analyzed case of a single missing Metamic rack bounds the additional scenarios discussed in this question or provide results for the limiting case.

g) The Attachment 5 licensing report includes an analysis of a postulated scenario where a seismic event occurs that results in a reduction in the spacing between SFP fuel storage racks. The results show that a reduction in SFP rack spacing can lead to a significant increase in reactivity. Please clarify what magnitude of seismic activity (e.g., relative to operating basis and safe shutdown earthquakes) would be necessary to result in spacing reductions such as that analyzed in the licensing report and further identify whether existing analyses allocate sufficient margin to accommodate such spacing reductions. If sufficient margin is not allocated, then please describe what controls are in place at HNP to ensure that smaller rack spacings resulting from a postulated seismic event do not become part of the normal condition (e.g., verification of adequate spacing between racks in the HNP SFP).

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