Proprietary Information – Withhold From Public Disclosure Under 10 CFR 2.390
The Balance Of This Letter May Be Considered Non-Proprietary Upon Removal Of Attachment 7

Entergy®

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Mandy K. Halter
Director, Nuclear Licensing

RBG-47900

October 24, 2018

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: License Amendment Request
Criticality Safety Analysis, Technical Specifications 4.3.1, *Criticality*, and Technical Specification 5.5, *Programs and Manuals*

River Bend Station - Unit 1
Docket No. 50-548
License No. NPF-47

Pursuant to 10 CFR 50.90, Entergy Operations, Inc. (Entergy) hereby requests approval of an amendment to the River Bend Station (RBS) Technical Specifications (TS). The proposed amendment includes: 1) a revision to the criticality safety analysis for the fuel handling building spent fuel pool; 2) additional requirements for the spent fuel pool storage racks in TS 4.3.1, *Criticality*; and 3) a requirement for the monitoring of the neutron absorber material in storage racks in TS 5.5, *Programs and Manuals*.

The proposed amendment is requested due to a change of the neutron absorbing material to be credited for the purpose of criticality control in the fuel handling building spent fuel pool.

Enclosure 1 includes the description of the change, no significant hazards consideration determination, and evaluation for environmental impact. Attachments to the Enclosure include: Attachment 1 provides a copy of the marked-up TS pages and Attachment 2 provides a copy of the clean TS pages. Attachment 3 contains the Non-Proprietary Version of Global Nuclear Fuel Report NEDO-33886, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018. Attachment 4 contains the NEI 12-16 Criticality Analysis Checklist. Attachment 7 is Proprietary in its entirety, as it contains information that is proprietary to Global Nuclear Fuel – Americas (GNF) and Curtiss-Wright Nuclear Division (CW). Attachments 5 and 6 contain the Proprietary Information Affidavits of these companies, respectively.

Accordingly, it is respectfully requested that the information proprietary to GNF and CW be withheld from public disclosure in accordance with 10 CFR 2.390.

The proposed change has been evaluated in accordance with 10 CFR 50.91(a)(1) using the criteria in 10 CFR 50.92(c) and it has been determined that the proposed change involves no significant hazards consideration.

Entergy requests prompt review and approval of this LAR to implement the proposed amendment to technical specifications by November 30, 2019. Once insert installation and LAR review and approval are complete, whichever date is later, the amendment will be implemented within 30 days.

In accordance with 10 CFR 50.91 (b)(1), Entergy is notifying the State of Louisiana and the State of Texas of this LAR by transmitting a copy of this letter with non-proprietary attachments to the designated State Official.

This letter does not contain any new commitments.

If you have any questions or require additional information, please contact Mr. Tim Schenk at 225.381.4177 or tschenk@entergy.com.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 24, 2018.

Sincerely,

Mandy K Halter

MKH/baj

Enclosure 1:	Evaluation of Proposed Technical Specifications Changes – Criticality Safety Analysis and Technical Specifications 4.3.1 and 5.5
Attachment 1:	Proposed Technical Specification Changes (Mark-up)
Attachment 2:	Proposed Technical Specification Changes (Clean)
Attachment 3:	Global Nuclear Fuel Report NEDO-33886, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018, (Non-Proprietary Version)
Attachment 4:	NEI 12-16 Criticality Analysis Checklist
Attachment 5:	Global Nuclear Fuel – Americas 10 CFR 2.390 Affidavit
Attachment 6:	Curtiss-Wright Nuclear Division 10 CFR 2.390 Affidavit
Attachment 7:	**PROPRIETARY** Global Nuclear Fuel Report NEDC-33886P, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018

cc:

NRC Regional Administrator - Region IV

NRC Project Manager - River Bend Station

NRC Senior Resident Inspector - River Bend Station

Louisiana Department of Environmental Quality
Office of Environmental Compliance
Radiological Emergency Planning and Response Section

Public Utility Commission of Texas

ENCLOSURE 1
RBG-47900
Evaluation of the Proposed Change - Criticality Safety Analysis and Technical Specifications 4.3.1 and 5.5

ATTACHMENTS:

Attachment 1: Proposed Technical Specification Changes (Mark-up)

Attachment 2: Proposed Technical Specification Changes (Clean)

Attachment 3: Global Nuclear Fuel Report NEDO-33886, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018 (Non-Proprietary Version)

Attachment 4: NEI 12-16 Criticality Analysis Checklist

Attachment 5: Global Nuclear Fuel – Americas 10 CFR 2.390 Affidavit

Attachment 6: Curtiss-Wright 10 CFR 2.390 Affidavit

Attachment 7: **PROPRIETARY** Global Nuclear Fuel Report NEDC-33886P, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018

1.0 SUMMARY DESCRIPTION

In accordance with 10 CFR 50.90, Entergy Operations, Inc. (Entergy) requests an amendment to Facility Operating License No. NPF-47 for River Bend Station – Unit 1 (RBS). The proposed change allows the crediting of NETCO-SNAP-IN® neutron absorbing rack inserts in the criticality safety analysis (CSA) for the storage rack cells in the station's fuel building spent fuel storage facility; i.e., the spent fuel pool (SFP). This change is being requested due to degradation of the Boraflex neutron absorbing material in the RBS SFP. The change seeks approval of the aforementioned CSA. The change also seeks approval of changes to Technical Specifications (TS) concerning criticality design features of the spent fuel storage racks (TS 4.3.1.1), to specifically identify the neutron absorbing inserts and fuel-related parameters used in the CSA, consistent with Standard Technical Specifications. Finally, the change seeks approval to add a program requirement that implements a monitoring program for the neutron absorbing rack inserts. The addition of this program requirement establishes consistency with Standardized Technical Specification improvement initiatives.

2.0 DETAILED DESCRIPTION

2.1 System Design and Operation

RBS Updated Safety Analysis Report (USAR) Section 9.1.2 documents the RBS SFP safety design bases as summarized below.

a. Nuclear – The fuel array in the fully loaded spent fuel racks is designed to be subcritical by at least 5 percent k. Geometrically safe configurations of fuel stored in the spent fuel array are employed to assure the k_{eff} does not exceed 0.95 under all normal and abnormal storage conditions. The geometry of the spent fuel storage array is such that k_{eff} will be $\leq$ 0.95 due to overmoderation.

b. Structural – The spent fuel storage racks are designed to withstand all credible static and dynamic loadings to prevent damage to the structure of the racks, and therefore the contained fuel; and to minimize distortion of the racks arrangement. The spent fuel storage racks are categorized as Safety Class 3 and Seismic Category I.

The RBS SFP contains 20 high density fuel storage rack units in three different modular arrays – a 12 x 13 matrix; a 13 x 13 matrix; and a modified 12 x 13 matrix which results in an 11 X 13 matrix with an additional nine defective fuel storage cells. This configuration provides a storage space sufficient for 3,172 boiling water reactor (BWR) fuel assemblies with flow channels and 9 defective fuel assemblies with their storage canisters. The loading of fuel assemblies in the SFP is limited to a maximum of 3,104 fuel assemblies (RBS TS 4.3.3.1). USAR Figure 9.1-3 shows the relative placement of the storage rack units.

The center-to-center spacing for the fuel assemblies within a storage rack unit is 6.28 inches and 8.5 inches between cell centers in adjacent rack units. Fuel assembly placement between adjacent storage cells or between rack units is not possible. The fuel storage racks are constrained horizontally by shear studs and vertically by the rack assembly and fuel assembly weight.

Each RBS storage rack unit employs Boraflex as a fixed neutron absorber for criticality control, to ensure that the effective neutron multiplication factor (k_{eff}) does not exceed the values and assumptions used in the CSA. This analysis is the basis, in part, for demonstrating compliance with plant TS requirements and U.S. Nuclear Regulatory Commission (NRC) regulations. The CSA methodology and inputs reflect the requirements of 10CFR50 Appendix A General Design Criterion 62, NUREG-0800 Section 9.1.2 Rev. 3 dated July 1981, Generic Letter 78-11, and ANSI N210-1976. Information regarding the Boraflex and the method of its integration into the RBS storage racks was provided in the station's response to Generic Letter 2016-01 (Reference 13).

2.2 Current Technical Specifications Requirements

The RBS TS requirements affected by this proposed change are TS Section 4.3.1, "Criticality" and TS Section 5.5, "Programs and Manuals".

- TS 4.3.1.1.a and 4.3.1.1.c identify requirements pertaining to the design of the SFP storage racks. Specifically, TS 4.3.1.1.a requires k_{eff} to be $\leq$ 0.95 if fully flooded with unborated water, which includes an allowance for uncertainties as described in USAR Section 9.1. TS 4.3.1.1.c requires a nominal 6.28 inch center-to-center distance between fuel assemblies placed within a rack in the SFP storage racks and 8.5 inches between cell centers of adjacent racks in the SFP.
- TS Section 5.5, "Programs and Manuals," does not contain requirements for a monitoring program for the neutron absorber used in the spent fuel pool storage racks.

2.3 Reason for the Proposed Change

Entergy plans to install NETCO-SNAP-IN® rack inserts in the RBS SFP storage racks in accordance with the provisions of 10 CFR 50.59. This provides an alternative method of neutron absorption to meet the maximum k_{eff} criticality control requirement without reliance on Boraflex, because the Boraflex has experienced degradation of its neutron absorbing capability as discussed in Reference 13. Entergy is requesting this license amendment to obtain approval for a new CSA that credits the use of the NETCO-SNAP-IN® rack inserts and does not credit Boraflex. The new CSA methodology and inputs reflect the requirements and guidance of 10 CFR 50 Appendix A General Design Criterion 62, 10CFR50.68, NUREG-0800, Section 9.1.1 Rev. 3 dated March 2007, Nuclear Energy Institute (NEI) 12-16 (Reference 1) and Nuclear Regulatory Commission (NRC) Interim Staff Guidance DSS-ISG-2010-01 (Reference 2).

With the crediting of the neutron absorbing rack inserts for criticality control, it is necessary to change RBS TS 4.3.1.1 to specifically identify as design features for spent fuel storage the neutron absorbing inserts and fuel-related parameters used in the CSA. The proposed change to Section 4.3.1.1 will make the RBS TS consistent with the "Standard Technical Specifications for General Electric BWR/6 Plants," NUREG-1434, Rev. 4.0 (ADAMS Accession No. ML12104A195) (Reference 10).

Finally, with the crediting of the neutron absorbing rack inserts for criticality control of the SFP, Entergy plans to implement a monitoring program consistent with NEI 16-03-A, "Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools," Revision 0 (ADAMS Accession No. ML17263A133) (Reference 11). NEI 16-03-A describes acceptable methods that may be used to monitor fixed neutron absorbers in SFPs to ensure that aging effects, corrosion, and other degradation mechanisms are identified and evaluated prior to loss of the required safety function. Since the RBS TS do not currently contain any requirements regarding the monitoring of fixed neutron absorbers in its SFP, with the addition of the NETCO-SNAP-IN® rack inserts into the SFP storage racks, Entergy seeks to establish a standardized TS program requirement that implements the aforementioned monitoring program. The proposed change is consistent with Technical Specifications Task Force (TSTF) traveler TSTF-557, "Spent Fuel Storage Rack Neutron Absorber Monitoring Program," Rev. 1 (ADAMS Accession No. ML17353A608) (Reference 12), currently under NRC review.

The proposed change is also consistent with Entergy's commitments for RBS license renewal, "License Renewal Application Update – Neutron Absorbing Material Monitoring Program –Supplement" (RBG-47848 dated March 22, 2018) (ADAMS Accession No. ML18081A018) (Reference 6), to install aluminum boron-carbide neutron absorbing material so that Boraflex material in the SFP will not be credited to perform a neutron absorber function and to implement a program that will follow the industry guidance provided in NEI 16-03-A (Reference 11).

The proposed change does not apply to the low density storage racks in the upper containment pool and the new fuel storage racks. These storage racks do not contain any neutron absorbing material for criticality control and will not have the new NETCO-SNAP-IN® rack inserts. The CSAs which apply to those storage racks remain unchanged by the new CSA provided with this proposed change.

2.4 Description of the Proposed Change

The proposed change consists of the following elements:

- A new CSA for the RBS SFP storage racks that credits the NETCO-SNAP-IN® rack inserts for criticality control and does not credit Boraflex;
- A revision of TS 4.3.1.1.d (formerly TS 4.3.1.1.c) to specifically identify the neutron absorber inserts as design features of the spent fuel storage racks;
- The addition of a new TS 4.3.1.1.a to add two fuel-related parameters (maximum k-infinity and maximum average U-235 enrichment) used in the CSA crediting the NETCO-SNAP- IN® rack inserts as design features of the spent fuel storage racks;
- The addition of new TS 5.5.15 to TS Section 5.5, "Programs and Manuals," to incorporate a program into the TS to monitor the condition of the neutron absorber inserts used in the SFP storage racks to ensure they will continue to perform their design function.

The changes to TS 4.3.1.1.a and TS 4.3.1.1.d will make the wording consistent with Standard Technical Specifications. The addition of TS 5.5.15 is consistent with the proposed TSTF-557, Rev. 1, which is under NRC review.

In addition to the above, an administrative change will be needed to renumber the current TS 4.3.1.1.a, TS 4.3.1.1.b, and TS 4.3.1.1.c to accommodate the addition of the new TS 4.3.1.1.a described above.

A markup of the proposed TS changes is provided in Attachment 1. The clean TS pages, incorporating these changes, are provided in Attachment 2. The USAR will also be revised, upon implementation of the approved amendment, as part of Entergy's configuration control process.

3.0 TECHNICAL EVALUATION

3.1 Overview

The following discussion will show that NETCO-SNAP-IN® rack inserts are a safe and effective replacement for Boraflex to ensure continued compliance with TS requirements. The proposed change will 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 keff $\leq$ 0.95 if fully flooded with unborated water..." The proposed change also includes changes to TS regarding design features and monitoring program requirements which are related to the analysis which credits these inserts.

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. As such, Entergy is not seeking NRC review and approval for installation of the inserts, only review and approval of the new CSA for crediting the inserts for criticality control in the RBS SFP. Therefore, Sections 3.1.1 through 3.1.3, Sections 3.3 through 3.7, and Section 3.8.2 are provided for information only.

Entergy will not credit the neutron absorbing capability of the inserts for criticality control under the new methodology until and unless this proposed change is approved. The Boraflex material is contained within the RBS spent fuel storage racks as part of their original fabrication and will remain in place and not be altered by installation of the NETCO-SNAP-IN® rack inserts. The rack inserts installation will begin following the Spring 2019 refueling outage and is projected to be completed by the end of October 2019.

3.1.1 Boraflex Degradation

Boraflex is used in the RBS SFP as a neutron-absorbing material and is credited in the CSA analysis of record (AOR) for the fuel building fuel storage racks. The condition of the Boraflex and the monitoring program used to measure changes in the material was documented in the station's response to Generic Letter 2016-01 (Reference 13). Consistent with the concern expressed in NRC Generic Letter 96-04, ""Boraflex Degradation in Spent Fuel Pool Storage Racks," the RBS monitoring program has identified degradation in the material, with an estimated areal density of 0.0171 g/cm^2 in the peak panel at the time the Generic Letter response was submitted. While this value is below the minimum certified Boraflex sheet areal density of 0.02 g/cm^2 specified by Westinghouse, the RBS storage rack vendor, it remains above the credited areal density of 0.016 g/cm^2. Nevertheless, with a loss in B_4C of approximately 1% per year estimated by the monitoring program, the credited limit is being approached, thereby prompting the need for an alternative neutron absorbing material to fulfill the neutron absorbing function in a new CSA.

3.1.2 NETCO-SNAP-IN® Rack Inserts Design Description

This proposed change credits NETCO-SNAP-IN® rack inserts for criticality control in 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 keff $\leq$ 0.95 if fully flooded with unborated water..."

The RBS NETCO-SNAP-IN® rack inserts will be fabricated from a homogeneous aluminum boron-carbide metal matrix material called BORALCAN® (formerly called

ALCAN), supplied by Rio Tinto Alcan. The NRC has approved this material for use in spent fuel racks at LaSalle County Station (LSCS), Peach Bottom Atomic Power Station, Units 2 & 3 (PBAPS), and Quad Cities Nuclear Power Stations, Units 1 & 2 (QCNPS) (References 7, 8, and 9, respectively). The NETCO-SNAP-IN® rack insert design that will be used at RBS has been employed in the installation and successful operation of a combined total of over 19,000 NETCO-SNAP-IN® inserts at these three stations.

While the basic design of the RBS inserts, and the material used in them, is the same as that used at LSCS, QCNPS, and PBAPS, the RBS inserts have a greater boron content of 21 volume percent B_4C. The dimensions of the RBS inserts are also slightly different because they are designed to fit into the RBS SFP storage racks, as determined by the performance of confirmatory dimensional sizing measurements in the RBS racks using non-borated test inserts of different wing widths and bend angles (see Section 3.4.3). A comparison of the insert dimensions and properties is provided in Section 3.3.3.

The NETCO-SNAP-IN® rack insert is designed to become an integral part of the rack upon installation, and does not require any modification to the spent fuel storage rack. The rack inserts slide into the rack and stay in place via friction with enough clearance still available for movement of fuel assemblies into and out of the storage cells. The insert is nominally the same length as a storage rack cell (approximately 169 inches), thereby spanning the full length of the active fuel region of the fuel assembly when installed. Each RBS insert is formed with a slightly greater than 90-degree bend angle, so that it is L-shaped (chevron shaped). 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 insert sides (or "wings") abut against the two adjacent faces of the SFP storage rack cell wall. The force exerted due to this deformation is determined by the material properties of the insert. The force between the wings of the 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® insert within the cell during normal fuel movement activities and under seismic events.

Entergy plans to install a NETCO-SNAP-IN® insert with the same orientation in every spent fuel storage location in the RBS SFP. This does not include the nine defective fuel storage cells, which are not part of the normal fuel storage cell locations and which are prohibited by station procedure for use as fuel storage locations. Installation of a NETCO-SNAP-IN® insert in every storage location and with the same orientation ensures that neutron absorption and critically control by the rack inserts is uniform across the SFP. A criticality analysis crediting the NETCO-SNAP-IN® inserts has been performed for the RBS SFP to support this design change. This analysis is discussed in Section 3.2.

3.1.3 Demonstration of Proposed Method for Rack Insert Installation

To verify the mechanical compatibility of the NETCO-SNAP-IN® insert with the RBS SFP storage racks and compatibility of the fuel stored therein, an insert demonstration program (i.e., the prototype installation and testing program) was performed at RBS in August 2018. The mechanical feasibility of using NETCO-SNAP-IN® rack inserts at RBS was verified by installing fifty-four (54) prototype inserts into randomly selected storage cells. After installation, retention load testing was performed on all 54 of the prototype inserts using the insert removal tool. Additionally, 52 of the storage cells containing prototype inserts were tested using a dummy fuel assembly, which has a cross-sectional dimension of a channeled fuel assembly, to verify adequate dimensional clearances between the insert and a fuel assembly during fuel handling. The NETCO-SNAP-IN® rack inserts used in the RBS prototype program were designed, fabricated, tested, and inspected under the NETCO quality assurance program to ensure they meet the design requirements for permanent inserts. In summary, the key insert parameters validated during the demonstration program were: 1) insertion installation success; 2) lack of fuel interference; and 3) retention force (i.e., greater than 150 lbf). These parameters are discussed in further detail below in Section 3.4.3, "Insertion / Retention Forces and Fuel Assembly Clearance."

3.2 Criticality

3.2.1 Criticality Evaluation for NETCO-SNAP-IN® Rack Inserts in RBS SFP

In accordance with the requirements of 10 CFR 50.68, a CSA was performed to support the storage of spent fuel in the RBS SFP with credit for the NETCO-SNAP-IN® inserts installed. All necessary requirements as outlined in NUREG-0800, Section 9.1.1 Rev. 3 dated March 2007, have been met. Nuclear Energy Institute's (NEI) NEI 12-16, Rev. 3 (Reference 1) and DSS-ISG-2010-01 (Reference 2) were used as guidance documents for this analysis. The analysis, described in Attachment 7, demonstrates that the maximum k-effective (k_{max} (95/95)) is substantially less than the 10 CFR 50.68 limit of 0.95 for normal and credible abnormal operation with tolerances and computational uncertainties taken into account. The analysis assumptions included:

- Uniform pool storage configuration with all fuel storage locations loaded with a NETCO-SNAP-IN® insert in the same orientation and a fuel bundle with the highest rack efficiency;
- A NETCO-SNAP-IN® insert Boron-10 (B-10) areal density of 0.0115 g/cm^2 (which is less than the minimum certified areal density of 0.0129 g B^{10}/cm^2);
- No credit for neutron absorption by the Boraflex material installed between the SFP storage rack cells, which has been modeled as water; and,
- The SFP fully flooded with unborated water.

The CSA covers all legacy fuel in storage at RBS; the current fuel product line in use at RBS, GNF2; and the planned future fuel, GNF3. The description of these product lines is provided in Section 4.0 of Attachment 7, while the disposition for all legacy fuel is provided in Appendix B of Attachment 7.

The reactivity of the RBS SFP storage rack containing NETCO-SNAP-IN® inserts was calculated using the computer codes TGBLA06 and MCNP-05P. In this evaluation, in-core k_∞ values and exposure dependent, pin-by-pin isotopic specifications were generated using TGBLA06, the NRC-approved GE-Hitachi Nuclear Energy Americas LLC (GEH)/GNF BWR lattice physics code. The fuel storage criticality calculations were then performed using MCNP-05P, the GEH/GNF proprietary version of the Las Alamos National Laboratory Monte Carlo neutron transport code MCNP5. TGBLA06 uses ENDF/B-V cross-section data to perform coarse-mesh, broad-group, diffusion theory calculations. MCNP-05P uses ENDF/B-VII.0 point-wise (i.e., continuous) cross-section data, and all reactions in the cross-section evaluation are considered. MCNP-

05P has been validated and verified for spent fuel pool storage rack evaluations in accordance with the NUREG/CR-6698 guidance (included as part of Attachment 7). The Method of Analysis is discussed in greater detail in Section 3.0 of Attachment 7. Validation of the codes and libraries is described in Section 3.4 and Appendix A of Attachment 7.

The use of TGBLA06 (Reference 14) for BWR core depletion calculations has been reviewed and accepted by the NRC as part of the approval of Reference 4. The NRC has also approved the MCNP-05P/TGBLA06 code package for use in a similar fuel pool criticality analysis, as documented in Reference 5. Finally, the NRC has approved use of these codes in the criticality analysis for a previous application of the NETCO-SNAP-IN® inserts in the PBAPS spent fuel pools, as documented in Reference 8. In addition to the request for approval of Attachment 7, which credits the NETCO-SNAP-IN® inserts for criticality control in the RBS SFP, there are two other related elements of the proposed change:

- A maximum cold, uncontrolled peak in-core k-infinity of 1.28 was set as the limit for this analysis. Furthermore, a maximum average fuel enrichment of 4.9 weight percent was determined to be the bounding enrichment for current and future fuel types at RBS. In the proposed TS 4.3.1.1.a, these values are incorporated into the RBS Design Features section on spent fuel storage criticality, consistent with Reference 10.
- In the proposed TS 4.3.1.1.d, the description of the neutron absorber inserts within the spent fuel storage racks is incorporated into the RBS Design Features section on spent fuel storage criticality, consistent with Reference 10.

3.2.2 NEI 12-16 and Interim Staff Guidance DSS-ISG-2010-01

NEI 12-16 (Reference 1) and NRC Interim Staff Guidance DSS-ISG-2010-01 (Reference 2) were used as the guidance documents for this analysis. Guidance pertaining to soluble boron in the SFP is not applicable because RBS is a BWR plant and has no soluble boron in the SFP. Attachment 4 includes the Criticality Analysis Checklist from NEI 12-16 to identify the areas of the analysis that conform or do not conform to the guidance in NEI 12-16.

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. Reference 3 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 SFP within design and regulatory limits over the life of the SFP storage racks. Qualification testing has been performed to confirm its acceptability and the monitoring program discussed in Section 3.9 will confirm its continued acceptability to perform its required design function in the RBS SFP.

The production process for manufacturing the rack inserts is described in detail in Reference 3. The technique developed by Rio Tinto Alcan to produce the aluminum/boron carbide metal matrix composite results in a homogeneous distribution of the B_4C in a rolled sheet, which is trimmed to produce rack insert blanks. Insert flats are then cut from the blanks and bent on a press brake to an angle somewhat larger than 90° to provide the chevron shaped insert and the long edges of the insert roll formed to establish the winglets. Additionally, test coupons are cut from each of the blanks and used to confirm acceptable minimum areal density and material properties.

3.3.1 Insert Boron-10 (B-10) Areal Density

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 0.0129 g/cm^2 for RBS. Verification of the minimum certified areal density of B-10 in the rack inserts (i.e., pre-characterization) is performed for 100 percent of the material used for the inserts. Each blank (from which the insert flats are cut) will have a traceable test coupon removed and subjected to neutron attenuation testing.

For each coupon, a specific areal density value is obtained, to which a 3-sigma (99.7%) uncertainty is applied, to confirm that the measured areal density exceeds the minimum certified areal density before the corresponding inserts are accepted. Given 100 percent sampling and the 3-sigma uncertainty applied to the measurement, RBS is assured that none of the inserts have an areal density below the minimum certified value. The CSA, discussed in Section 3.2.1, assumes an insert B-10 areal density of 0.0115 g/cm^2, which is significantly less than the minimum certified areal density of 0.0129 g B^{10}/cm^2.

Reference 3, Section 3.4 (Table 3.1), 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 certified 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 the minimum certified 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 certified B-10 areal density for their plant's inserts in the procurement specification. For RBS, the minimum certified manufactured B-10 areal density value is 0.0129 g/cm^2. Verification of the areal density of B-10 over the lifetime of the racks will be performed through the rack insert monitoring program discussed in Section 3.9.

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 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 Section 5.0 of Reference 3. The material qualification program included material at 16 volume percent and 25 volume percent loadings of boron carbide (B_4C). This range of as-tested boron carbide loadings of the test coupons bounds the loading to be used at RBS (21 volume percent B_4C).

In summary, the material qualification test program concluded that the AA1100 aluminum alloy/boron carbide composite produced by Rio Tinto Alcan is a highly suitable neutron absorber for use in spent fuel storage racks. The program determined that general corrosion of the material would occur at an extremely low rate (approximately 0.02 mils/year); no local corrosion (pitting) or cracking was detected; and there was no measurable change in the B-10 areal density. The program also determined, through a review of pertinent literature, that the aluminum alloy used to make the inserts is not susceptible to stress corrosion cracking (SCC). Verification that unexpected material degradation is not occurring, over the lifetime of the racks, will be performed through the rack insert monitoring program discussed in Section 3.9.

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

The NETCO-SNAP-IN® rack inserts to be used in the RBS spent fuel storage pools are dimensionally and physically similar to those already in use at three other BWR stations -- LSCS, PBAPS, and QCNPS, as shown in Table 3.3-1.

Table 3.3-1
Insert Dimension / Property Comparison

Dimension or Property	RBS	LSCS	PBAPS	QCNPS
Length (in.)	169	167.75	169	Style 1 – 165.25 Style 2 – 165.00
Thickness (in.)	0.080	0.065	0.075	0.085
B-10 Min Areal Density (g/cm^2)	0.0129	0.0087	0.0105	0.0116
B_4C Density (vol %)	21	17	19	17

3.4 Mechanical

3.4.1 Fuel Assembly Clearances

Placement of the rack insert in a SFP storage rack cell slightly reduces the cell inside dimension available for fuel assembly insertion. The prototype installation and testing program (Sections 3.1.3 and 3.4.3) confirmed adequate clearance between a fuel assembly and rack cells containing prototype 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 5.5.2 of Attachment 7).

If a channeled spent fuel assembly cannot fit into the spent fuel storage rack cells containing rack inserts due to mechanical clearances, the fuel assembly may be de-channeled and stored. The new criticality analysis demonstrates that this is a conservative configuration compared to storing fuel assemblies with the channel (see Section 5.4.2 of Attachment 7).

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 clearance between the fuel and insert has been verified using a dummy fuel assembly, as part of the prototype testing (see Sections 3.1.3 and 3.4.3). The combined effects of adequate clearance and infrequent fuel assembly movement will preclude significant wear of the rack insert.

3.4.3 Insertion / Retention Forces and Fuel Assembly Clearance

Dimensional Sizing Testing

Past experience from installing the NETCO-SNAP-IN® inserts in other spent fuel storage racks has shown that the manufactured dimensions for the rack cells do not always match the tolerances shown on design drawings. Because the NETCO-SNAP-IN® insert relies heavily on the spring force of the insert obtained when compressing the insert into the cell, even small deviations of the cell dimensions can have a large impact on how an insert fits into a rack cell. In order to determine the optimal wing width and initial bend angle needed for an insert to successfully fit into the RBS spent fuel storage racks, test inserts made from non-borated, 3000 series aluminum were installed into and removed from sixty (60) randomly selected fuel storage cells in the RBS SFP in November 2017. The main purpose of these test installations was to provide a basis for determining the appropriate size of the wing width and initial bend angle needed for the final insert design that will be installed in the RBS SFP. Load tests were also performed during the removal of these test inserts to determine the force required to remove the insert. Due to slight differences in mechanical properties of the materials, the load test results for the aluminum test inserts were not expected to be identical to those of the inserts made from BORALCAN®. However, the results were useful as a guide to ensure the final design of the absorber inserts will provide the minimum force required for insert removal.

Prototype Installation and Testing

A demonstration program using prototype NETCO-SNAP-IN® rack inserts was completed at RBS in August 2018, as described in Section 3.1.3 above. The prototype installation and testing provided a confirmation that BORALCAN® inserts, made to the final design, meet the interference and retention load testing requirements. The RBS specific parameters observed during the demonstration program were: (1) installation force; (2) retention force (greater than 150 lbs); and (3) fuel assembly clearance. Additional detail is provided below.

Insertion Force – The insertion or installation force is produced by the installation tool, 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 is less than 1000 pounds to maintain a load under the hoist limit for the refueling bridge auxiliary hoist. It is also less than the heavy load limit for RBS of 1200 pounds. Some of the installation tool weight is due to the external frame that is part of the tool design that helps to guide the insert into place, and therefore the full weight of the tool is not applied to seat the insert. Most of the time, the weight provided is sufficient. But in some instances, the insert may stop just before it is fully seated into the storage rack cell. In those cases, a separate insert setting tool, which does not have the external frame of the installation tool, is used to provide additional force to fully seat the insert the last few inches. 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 the stainless steel SFP storage racks and will not damage the existing racks.

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). The minimum acceptable force was 150 lbf, which meets the RBS specific design criteria for seismic accelerations and stress relaxation (see Section 3.4.4 below). It also provides a significant margin in retention force to reduce the possibility that the insert will move during normal fuel movement operations due to drag force, if the fuel were to contact the insert during removal from a storage cell.

Fuel Assembly Clearance – During the prototype installation and testing program, a dummy fuel assembly was inserted and then removed from fifty-two (52) test locations in which a prototype insert was installed, with no indication of clearance issues. The dummy fuel assembly used has a cross-sectional dimension of a channeled fuel assembly. This testing was performed to confirm that the installed inserts would not interfere with fuel movement.

In summary, the results of the prototype installation and testing program demonstrated the mechanical compatibility of the inserts with the RBS spent fuel storage racks and compatibility with the fuel stored therein. The results provide reasonable assurance that NETCO-SNAP-IN® inserts will perform their intended safety function when installed in the RBS 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 Reference 3, Section 4.1).

The RBS insert design has an assumption of a maximum of 60% stress relaxation during the course of its service life (20 years). This assumption is conservative due to the reinforcing properties of the boron carbide particles. This assumption was used to determine the minimum retention force requirements of the inserts during installation, discussed in Section 3.4.3, that would hold the inserts in place during a seismic event even after relaxation has occurred.

3.5 Seismic

A reconciliation of the seismic AOR for RBS was performed to demonstrate that the conclusions developed in the original analysis remain valid with the inserts installed in the RBS spent fuel storage racks. The reconciliation considered the increase in weight and seismic loads on the spent fuel pool racks due to the addition of the inserts. The reconciliation evaluation determined that the additional weight of the inserts resulted in an increase in seismic loads proportional to the added weight of the inserts. The resulting seismic loads were determined and used throughout the structural analysis reconciliation discussed in Section 3.6. As noted in that section, the addition of the inserts does not cause an impact that would compromise the structural integrity of the rack. The reconciliation further evaluated, due to seismic displacement, the impact of the inserts on the conditions of rack lift off, rack-to-rack deflections, and rack-to-wall deflections. For all conditions, it was concluded that the allowable limits were not exceeded as a result of the addition of the inserts. Finally, the concern that an insert may slide upwards out of the rack cell during a seismic event was evaluated. It was determined that the total force on the insert during a seismic event (the weight of the insert accelerated upward based on an increase in acceleration for the seismic event) was not sufficient to overcome the total friction force between the insert and the cell wall. The prototype installation and testing program confirmed that sufficient retention force exists to prevent the insert from moving upward during a seismic event (see Section 3.4.3).

3.6 Structural

A reconciliation of the structural AOR for the RBS spent fuel storage racks was performed to demonstrate that the conclusions developed in the analysis remain valid with the NETCO-SNAP-IN® rack inserts installed. The margins of safety calculated in the AOR were used as a basis for reconciliation. Each of the components analyzed in the AOR was evaluated for changes in the margin of safety, to determine if the addition of the inserts will increase the stresses under normal and seismic conditions such that the results become unacceptable. These evaluated components included:

- The fuel storage cell assemblies (axial and shear stresses on the fuel storage cell, and shear stresses on the cell to cell, cell seam, and cell to base plate welds);
- The fuel storage rack support assemblies (compression and bending on the support pad screw, shear and bending on the support pad, and thread shear on the support pad threads);
- The support structure (shear on threaded block to plate welds); and
- The support plates (compression, bending, and shear stresses on the plates, shear stress on the structure to base plate welds, shear stress on plate to plate welds, and bending and shear stress on shear pin).

The evaluation determined that the changes in margins of safety for each component due to the addition of the inserts were not significant enough to produce unacceptable results. Therefore, it is concluded that the addition of the inserts does not cause an impact that would compromise the structural integrity of the rack.

The structural performance of the NETCO-SNAP-IN® rack inserts under RBS design conditions was also evaluated. The objective of this evaluation was to confirm that the neutron absorber inserts will continue to perform their safety function under the required loading conditions. It was concluded that in the installed condition at RBS, stresses on the inserts will be significantly less than the material yield strength and therefore the inserts will not deform plastically. Additionally, it was concluded that no additional stresses will be produced as a result of thermal expansion. Finally, it was concluded that the installation of the insert will not cause the storage rack to fail due to the stresses produced during installation.

3.7 Thermal-Hydraulic

A reconciliation of the thermal-hydraulic AOR for the RBS spent fuel storage racks was performed to demonstrate that the conclusions developed in the analysis remain valid with the NETCO-SNAP-IN® inserts installed. Changes in the fuel storage cell geometry due to the addition of the inserts were evaluated for both the channeled and unchanneled fuel assembly cases. The effects of these changes on the thermal-hydraulic analysis was then determined and it was concluded, for both cases, that the addition of the NETCO-SNAP-IN® inserts will not adversely affect the existing thermal-hydraulic analysis.

3.8 Accident Conditions

3.8.1 Accident Considerations Related to Criticality

As part of the criticality analysis discussed in Section 3.2 and described in Attachment 7, the spent fuel rack configuration was analyzed for credible accident scenarios. The scenarios analyzed are listed below and are discussed in Section 5 of Attachment 7.

- Dropped / damaged fuel
- Abnormal positioning of a fuel assembly outside the fuel storage rack
- Abnormal positioning of a fuel assembly in defective fuel storage location

In addition, the following scenarios were considered bounded by the analysis, with the justification provided in Section 5 of Attachment 7.

- Dropped fuel assembly on rack
- Closure of water gap between racks caused by rack sliding due to seismic event
- Loss of spent fuel cooling

The analysis, described in Attachment 7, demonstrates that the maximum k-effective (k_{max}(95/95)) is less than the 10 CFR 50.68 limit of 0.95 for normal and credible abnormal operation with tolerances and computational uncertainties taken into account.

3.8.2 Fuel Handling Accident

A reconciliation review of the fuel drop AOR was performed to verify that the spent fuel storage racks with NETCO-SNAP-IN® inserts will continue to accommodate the fuel handling uplift load and impact loadings resulting from the analyzed fuel assembly drop accidents. The evaluation of the drop of a fuel assembly on top of a rack with an installed insert concluded that results would be less severe because the insert would contribute to absorbing a portion of the impact energy.

The evaluation of a fuel handling uplift load with the inserts installed concluded that addition of the inserts does not impact this analysis. Additionally, insert and insert tool drop accidents were evaluated including (a) the straight drop of an insert and insert tool onto the top of a rack; (b) an inclined drop onto the top of a rack; and (c) a straight drop through the cell to the bottom of the rack. For all cases, the review concluded that the accidental drop of the inserts and insert tool would not adversely affect the results of the AOR.

3.9 Rack Insert Monitoring Program

RBS has committed to the monitoring program for the SFP neutron absorbing inserts described in Section A.1.3 of the USAR supplement of the RBS license renewal application (Reference 6). The NRC staff has reviewed this program as documented in the license renewal safety evaluation (Reference 15). The program will be consistent with the NRC-recommended program described in NUREG-1801, Revision 2, Section XI.M40, Monitoring of Neutron-Absorbing Materials Other than Boraflex. Upon issuance of the RBS renewed operating license, the program will become part of the RBS USAR and the licensing basis.

The program will use monitoring coupons and in-situ inspections and will follow the most current industry guidance (Reference 11). Degradation of the neutron absorbing material that could compromise the criticality analysis will be detected to assure that the required 5% sub-criticality margin is maintained during the period of extended operation. The parameters monitored include the physical condition and dimensions (e.g., corrosion, pitting, wear, blisters, and bulges) and areal density (neutron absorber loss). Inspection and test frequencies will be based on plant-specific experience and will be informed by industry operating experience, but will be at least once every 10 years. Test results will be trended and, if necessary, corrective action will be taken to ensure the subcriticality margin is maintained.

Since the RBS TS do not contain any requirements regarding the monitoring of fixed neutron absorbers in its SFP, with the addition of the NETCO-SNAP-IN® rack inserts into the SFP storage racks, Entergy seeks to establish a standardized TS program requirement that implements the aforementioned monitoring program. The proposed change, the addition of TS 5.5.15, is consistent with Reference 12, currently under NRC review.

3.10 Summary and Conclusions

The proposed change to credit the NETCO-SNAP-IN® rack inserts in the SFP storage racks for criticality control 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 RBS SFP storage racks, ensuring that the plant's safety design bases for the SFP continue to be maintained. Furthermore, the proposed change establishes consistency with Standardized Technical Specification Improvement initiatives and satisfies the commitment Entergy made to implement a Neutron Absorbing Material Monitoring Program for license renewal for RBS.

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 RBS SFP CSA crediting the neutron absorbing rack inserts, provided as Attachment 7 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. The aforementioned CSA assumes a maximum of 4.9 percent by weight U-235 enrichment for current and future fuel used at RBS and the proposed addition of TS 4.3.1.1.a formalizes this limit.

General Design Criterion (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 conformance with GDC 62 is discussed in Section 9.1.2, "Spent Fuel Storage," of the RBS USAR. The NETCO-SNAP-IN® rack insert CSA has been performed to demonstrate that keff will remain less than or equal to 0.95 with no credit taken for the Boraflex neutron poison material in the spent fuel storage racks in the final configuration.

4.2 Precedent

The NRC has approved the use of NETCO-SNAP-IN® rack inserts as an alternative method of criticality control to address Boraflex degradation for three other plants as documented in References 7, 8, and 9. If the proposed change is approved, RBS would become the fourth boiling water reactor (BWR) nuclear station to credit use of NETCO-SNAP-IN® rack inserts for criticality control in the SFP.

Additionally, the NRC has approved NEI 16-03-A (Reference 11) concerning guidance for monitoring of fixed neutron absorbers in spent fuel pools. The requested change to add a new program to the RBS TS for monitoring of the neutron absorbing rack inserts is consistent with Reference 11. It is also consistent with Reference 12, which is under NRC review.

4.3 No Significant Hazards Consideration

In accordance with 10 CFR 50.90, Entergy Operations, Inc. (Entergy) requests an amendment to Facility Operating License No. NPF-47 for River Bend Station (RBS) – Unit 1. The proposed change requests NRC approval for:

- The crediting of NETCO-SNAP-IN® neutron absorbing rack inserts in the criticality safety analysis (CSA) for the storage rack cells in the station's fuel building spent fuel storage facility; i.e., the spent fuel pool (SFP). This change is being requested due to degradation of the Boraflex neutron absorbing material currently being used in the RBS SFP.
- Changes to Technical Specifications (TS) concerning criticality design features of the spent fuel storage racks (TS 4.3.1.1), to specifically identify the neutron absorbing inserts and fuel-related parameters used in the CSA, consistent with Standard Technical Specifications (NUREG-1434).
- The addition of a TS program requirement (TS 5.5.15) that implements a monitoring program for the neutron absorbing rack inserts. The addition of this program requirement establishes consistency with a Standardized Technical Specification Improvement initiative (TSTF-557, Rev. 1), which is under NRC review.

According to 10 CFR 50.92, 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.

Entergy has evaluated the proposed change for RBS 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. **Will operation of the facility in accordance with this proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?**

Response: No

The proposed change involves a new CSA for the RBS SFP to credit the neutron absorbing capability of the NETCO-SNAP-IN® rack inserts installed in the SFP storage rack cells for criticality control. The neutron absorbing capability of the Boraflex material contained in the SFP storage racks would no longer be credited. The new CSA is not a physical change to the plant and does not affect the ability of any structures, systems or components (SSCs) to perform a design function. The proposed new CSA demonstrates adequate margin to criticality for spent fuel storage rack cells and therefore does not affect the consequences of any accident previously evaluated.

The proposed change also involves changes to the requirements specified in TS 4.3.1.1 for spent fuel storage racks. These changes are consistent with the new CSA and impose additional requirements in the plant's Technical Specifications. These new requirements for the spent fuel storage racks do not involve a physical change to any plant systems and do not affect the ability of any SSCs to perform a design function. The new requirements support the assumptions of the new CSA and therefore do not affect the consequences of any accident previously evaluated.

Finally, the proposed change involves the addition of a new programmatic requirement in TS 5.5 to perform monitoring of the NETCO-SNAP-IN® rack inserts to ensure that they continue to perform their design function, consistent with the assumptions of the new CSA. Monitoring of the SFP neutron absorber does not affect the ability of any SSCs to perform a design function. A SFP storage rack neutron absorber monitoring program is not an initiator to any accident previously evaluated and does not affect the consequences of any accident previously evaluated.

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

2. **Will operation of the facility in accordance with this 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 RBS spent fuel pool is a normal activity for which RBS has been designed and licensed. The new CSA does not involve any physical changes to the plant and does not change the method of spent fuel movement or storage. It only provides an analysis of the existing SFP storage racks, with credit for the NETCO-SNAP-IN® rack inserts, to demonstrate adequate margin to criticality.

Similarly, the addition of new requirements in TS 4.3.1.1 for the spent fuel storage racks and a requirement in TS 5.5 for a new SFP storage rack neutron absorber monitoring program does not involve any physical changes to the plant and does not change the method of spent fuel movement or storage.

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. **Will operation of the facility in accordance with this proposed change involve a significant reduction in a margin of safety?**

Response: No

The safety margin which is relevant to the proposed change is the safety margin for criticality in spent fuel storage racks. This margin is 5% (i.e., Keff less than or equal to 0.95 when fully flooded with unborated water), including a conservative margin to account for engineering and manufacturing uncertainties. The new CSA demonstrates that this margin is maintained when the NETCO-SNAP-IN® rack inserts are credited for criticality control in the RBS SFP, without credit for Boraflex.

The safety margin is unaffected by the addition of new requirements in TS 4.3.1.1 for the spent fuel storage racks. The new requirements are consistent with the assumptions of the new CSA and therefore support the basis of the safety margin demonstrated in the CSA.

The addition of a new programmatic requirement in TS 5.5 to perform monitoring of the SFP neutron absorber inserts does not affect the margin to safety for criticality. Performance of monitoring in accordance with this new requirement will support the criticality safety margin as it provides assurance that the inserts continue to perform their assumed design function which is credited in the new CSA.

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

Based on the above evaluation, Entergy 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

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

The proposed change does not change any requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or does not change an inspection or surveillance requirement. The proposed change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed change meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9).

Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed change.

6.0 REFERENCES

1. NEI 12-16, Revision 3, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants," March 2018. (ADAMS Accession Number ML18088B400)
2. NRC Interim Staff Guidance DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," Revision 0 (ADAMS Accession Number ML110620086)
3. NETCO Report NET-259-03, Revision 5, "Material Qualification of Alcan Composite for Spent Fuel Storage," August 2008 (ADAMS Accession Number ML13199A039)
4. NRC Letter: Amendment 26 to GE Licensing Topical Report NEDE-24011-P-A, "GESTAR II" – Implementing Improved GE Steady-State Methods (TAC No. MA6481) (ADAMS Accession Number ML993230387)
5. NRC Letter: Final Safety Evaluation for GE Hitachi Nuclear Energy Licensing Topical Report NEDC-33374P, Revision 3, "Safety Analysis Report for Fuel Storage Racks Criticality Analysis for ESBWR Plants", September 21, 2010 (ADAMS Accession Number ML102430580)
6. Entergy Letter: License Renewal Application Update – Neutron Absorbing Material Monitoring Program –Supplement (RBG-47848 dated March 22, 2018) (ADAMS Accession No. ML18081A018)
7. LaSalle County Station, Units 1 and 2 – Issuance of Amendments Concerning Spent Fuel Neutron Absorbers (TAC Nos. ME2376 and ME2377), dated January 28, 2011 (ADAMS Accession No. ML110250051)
8. 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 (ADAMS Accession No. ML13114A929)
9. Quad Cities Nuclear Power Station, Units 1 and 2 – Issuance of Amendments Regarding NETCO Inserts (TAC Nos. MF2489 and MF2490)(RS-13-148), dated December 31, 2014 (ADAMS Accession No. ML14346A306)
10. NUREG-1434, Rev. 4.0, Standard Technical Specifications for General Electric BWR/6 Plants (ADAMS Accession No. ML12104A195)
11. NEI 16-03-A, "Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools," Revision 0, March 2017 (ADAMS Accession No. ML17263A133)
12. TSTF-557, "Spent Fuel Storage Rack Neutron Absorber Monitoring Program," Rev. 1, dated December 19, 2017 (ADAMS Accession No. ML17353A608)
13. Entergy Letter: Response to Generic Letter 2016-01, "Monitoring of Neutron Absorbing Materials in Spent Fuel Pools" (RBG-47720 dated November 2, 2016) (ADAMS Accession No. ML16323A224).
14. General Electric Company, "Steady-State Nuclear Methods," NEDE-30130-P-A, April 1985 (Non-Proprietary Version - ADAMS Accession No. ML14104A064).
15. NRC Letter and Enclosure: Safety Evaluation Report Related to the License Renewal of River Bend Station, Unit 1 (TAC No. MF9757), August 16, 2018 (ADAMS Accession Numbers ML18138A355 and ML18212A151).

ATTACHMENT 1
RBG-47900

PROPOSED TECHNICAL SPECIFICATION CHANGES

(MARK-UP)

4.0 DESIGN FEATURES

4.1 Site Location

The River Bend Station is located in West Feliciana Parish, Louisiana, on the east bank of the Mississippi River approximately 24 miles north-northwest of Baton Rouge (city center), Louisiana. The site comprises approximately 3342 acres. The exclusion area boundary shall have a radius of 3000 feet from the centerline of the reactor.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 624 fuel assemblies. Each assembly shall consist of a matrix of Zircaloy or ZIRLO clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

4.2.2 Control Rod Assemblies

The reactor core shall contain 145 cruciform shaped control rod assemblies. The control material shall be boron carbide or hafnium metal, or both.

4.3 Fuel Storage

4.3.1 Criticality

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

a. Fuel assemblies having a maximum k-infinity of 1.28 in the normal reactor core configuration at cold conditions and a maximum average U-235 enrichment of 4.9 weight percent;

b. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1 of the USAR;

(continued)

4.0 DESIGN FEATURES

4.3.1.1 (continued)

c. A nominal fuel assembly center to center storage spacing of 7 inches within rows and 12.25 inches between rows in the low density storage racks in the upper containment pool; and

d. A nominal fuel assembly center to center storage spacing of 6.28 inches within a rack and 8.5 inches between cell centers of adjacent racks, with a neutron absorber insert within the storage cells, in the high density storage racks in the spent fuel storage facility in the Fuel Building.

4.3.1.2 The new 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 9.1.1 of the USAR;

b. A nominal fuel assembly center to center storage spacing of 7 inches within rows and 12.25 inches between rows in the new fuel storage racks.

4.3.2 Drainage

The spent fuel storage pool is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 95 ft.

4.3.3 Capacity

4.3.3.1 The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 3104 fuel assemblies.

4.3.3.2 No more than 200 fuel assemblies may be stored in the upper containment pool.

5.5 Programs and Manuals

5.5.14 Control Room Envelope Habitability Program (continued)

OPERABLE Control Room Fresh Air (CRFA) System, CRE occupants can control the reactor safely under normal conditions and maintain it in a safe condition following a radiological event, hazardous chemical release, or a smoke challenge. The program shall ensure that adequate radiation protection is provided to permit access and occupancy of the CRE under design basis accident (DBA) conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent (TEDE) for the duration of the accident. The program shall include the following elements:

a. The definition of the CRE and the CRE boundary.

b. Requirements for maintaining the CRE boundary in its design condition including configuration control and preventive maintenance.

c. Requirements for (i) determining the unfiltered air inleakage past the CRE boundary into the CRE in accordance with the testing methods and at the Frequencies specified in Sections C.1 and C.2 of Regulatory Guide 1.197, "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors," Revision 0, May 2003, and, (ii) assessing CRE habitability at the Frequencies specified in Sections C.1 and C.2 of Regulatory Guide 1.197, Revision 0, except that testing specified at a frequency of 18 months is required at a frequency of 24 months.

d. Measurement, at designated locations, of the CRE pressure relative to all external areas adjacent to the CRE boundary during the pressurization mode of operation by one subsystem of the CRFA System, operating at the flow rate required by the VFTP, at a Frequency of 24 months on a STAGGERED TEST BASIS. The results shall be trended and used as part of the 24 month assessment of the CRE boundary.

e. The quantitative limits on unfiltered air inleakage into the CRE. These limits shall be stated in a manner to allow direct comparison to the unfiltered air inleakage measured by the testing described in paragraph c. The unfiltered air inleakage limit for radiological challenges is the inleakage flow rate assumed in the licensing basis analyses of DBA consequences. Unfiltered air inleakage limits for hazardous chemicals must ensure that exposure of CRE occupants to these hazards will be within the assumptions in the licensing basis.

(continued)

5.5 Programs and Manuals

5.5.14 Control Room Envelope Habitability Program (continued)

f. The provisions of SR 3.0.2 are applicable to the Frequencies for assessing CRE habitability, determining CRE unfiltered inleakage, and measuring CRE pressure and assessing the CRE boundary as required by paragraphs c and d, respectively.

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5.5.15 Spent Fuel Storage Rack Neutron Absorber Monitoring Program

This program provides controls for monitoring the condition of the neutron absorber inserts used in the high density storage racks in the spent fuel storage facility in the Fuel Building to verify the Boron-10 areal density is consistent with the assumptions in the spent fuel pool criticality analysis. The program shall be in accordance with NEI 16-03-A, "Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools," Revision 0, May 2017.

ATTACHMENT 2
RBG-47900

PROPOSED TECHNICAL SPECIFICATION CHANGES

(CLEAN)

4.0 DESIGN FEATURES

4.1 Site Location

The River Bend Station is located in West Feliciana Parish, Louisiana, on the east bank of the Mississippi River approximately 24 miles north-northwest of Baton Rouge (city center), Louisiana. The site comprises approximately 3342 acres. The exclusion area boundary shall have a radius of 3000 feet from the centerline of the reactor.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 624 fuel assemblies. Each assembly shall consist of a matrix of Zircaloy or ZIRLO clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

4.2.2 Control Rod Assemblies

The reactor core shall contain 145 cruciform shaped control rod assemblies. The control material shall be boron carbide or hafnium metal, or both.

4.3 Fuel Storage

4.3.1 Criticality

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

a. Fuel assemblies having a maximum k-infinity of 1.28 in the normal reactor core configuration at cold conditions and a maximum average U-235 enrichment of 4.9 weight percent;

b. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1 of the USAR;

(continued)

4.0 DESIGN FEATURES

4.3.1.1 (continued)

c. A nominal fuel assembly center to center storage spacing of 7 inches within rows and 12.25 inches between rows in the low density storage racks in the upper containment pool; and

d. A nominal fuel assembly center to center storage spacing of 6.28 inches within a rack and 8.5 inches between cell centers of adjacent racks, with a neutron absorber insert within the storage cells, in the high density storage racks in the spent fuel storage facility in the Fuel Building.

4.3.1.2 The new 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 9.1.1 of the USAR;

b. A nominal fuel assembly center to center storage spacing of 7 inches within rows and 12.25 inches between rows in the new fuel storage racks.

4.3.2 Drainage

The spent fuel storage pool is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 95 ft.

4.3.3 Capacity

4.3.3.1 The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 3104 fuel assemblies.

4.3.3.2 No more than 200 fuel assemblies may be stored in the upper containment pool.

5.5.14 Control Room Envelope Habitability Program (continued)

OPERABLE Control Room Fresh Air (CRFA) System, CRE occupants can control the reactor safely under normal conditions and maintain it in a safe condition following a radiological event, hazardous chemical release, or a smoke challenge. The program shall ensure that adequate radiation protection is provided to permit access and occupancy of the CRE under design basis accident (DBA) conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent (TEDE) for the duration of the accident. The program shall include the following elements:

a. The definition of the CRE and the CRE boundary.

b. Requirements for maintaining the CRE boundary in its design condition including configuration control and preventive maintenance.

c. Requirements for (i) determining the unfiltered air inleakage past the CRE boundary into the CRE in accordance with the testing methods and at the Frequencies specified in Sections C.1 and C.2 of Regulatory Guide 1.197, "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors," Revision 0, May 2003, and, (ii) assessing CRE habitability at the Frequencies specified in Sections C.1 and C.2 of Regulatory Guide 1.197, Revision 0, except that testing specified at a frequency of 18 months is required at a frequency of 24 months.

d. Measurement, at designated locations, of the CRE pressure relative to all external areas adjacent to the CRE boundary during the pressurization mode of operation by one subsystem of the CRFA System, operating at the flow rate required by the VFTP, at a Frequency of 24 months on a STAGGERED TEST BASIS. The results shall be trended and used as part of the 24 month assessment of the CRE boundary.

e. The quantitative limits on unfiltered air inleakage into the CRE. These limits shall be stated in a manner to allow direct comparison to the unfiltered air inleakage measured by the testing described in paragraph c. The unfiltered air inleakage limit for radiological challenges is the inleakage flow rate assumed in the licensing basis analyses of DBA consequences. Unfiltered air inleakage limits for hazardous chemicals must ensure that exposure of CRE occupants to these hazards will be within the assumptions in the licensing basis.

(continued)

5.5 Programs and Manuals

5.5.14 Control Room Envelope Habitability Program (continued)

f. The provisions of SR 3.0.2 are applicable to the Frequencies for assessing CRE habitability, determining CRE unfiltered inleakage, and measuring CRE pressure and assessing the CRE boundary as required by paragraphs c and d, respectively.

5.5.15 Spent Fuel Storage Rack Neutron Absorber Monitoring Program

This program provides controls for monitoring the condition of the neutron absorber inserts used in the high density storage racks in the spent fuel storage facility in the Fuel Building to verify the Boron-10 areal density is consistent with the assumptions in the spent fuel pool criticality analysis. The program shall be in accordance with NEI 16-03-A, "Guidance for Monitoring of Fixed Neutron Absorbers in Spent Fuel Pools," Revision 0, May 2017.

ATTACHMENT 3
RBG-47900

GLOBAL NUCLEAR FUEL REPORT
NEDO-33886

"RIVER BEND STATION: FUEL STORAGE CRITICALITY SAFETY ANALYSIS OF SPENT FUEL STORAGE RACKS WITH RACK INSERTS"

REVISION 1

October 2018

(NON-PROPRIETARY VERSION)

Global Nuclear Fuel

Global Nuclear Fuel

NEDO-33886
Revision 1
October 2018

Non-Proprietary Information

River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts

INFORMATION NOTICE

This is a non-proprietary version of the document NEDC-33886P, Revision 1, which has the proprietary information removed. Portions of the document that have been removed are indicated by an open and closed bracket as shown here [[ ]].

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

Please Read Carefully

The design, engineering, and other information contained in this document is furnished for the purpose of providing the results of the spent fuel pool criticality analysis for River Bend Station. The only undertakings of GNF with respect to information in this document are contained in the contracts between Entergy and GNF, and nothing contained in this document shall be construed as changing the contract. The use of this information by anyone other than Entergy, or for any purpose other than that for which it is intended is not authorized; and with respect to any unauthorized use, GNF makes no representation or warranty, express or implied, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document, or that its use may not infringe privately owned rights.

Revision Status

Revision Number	Date	Description of Change
0	June 2018	Initial issue.
1	October 2018	• Added clarification to Table 3. • Updated wording for reconstituted fuel in Section 4.0. • New minimum insert wing length.

Table of Contents

List of Tables

List of Figures

ACRONYMS

Term	Definition
2D	Two-Dimensional
AOA	Area of Applicability
BOL	Beginning-of-Life
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
EALF	Energy of the Average Lethargy causing Fission
GEH	GE-Hitachi Nuclear Energy Americas LLC
GNF	Global Nuclear Fuel - Americas, LLC
H/X	Hydrogen-to-Fissile Ratio
MOX	Mixed Uranium-Plutonium Oxide
NCA	Nuclear Critical Assembly
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
SS	Stainless Steel
TCS	Tank Critical Assembly
WREC	Westinghouse Reactor Evaluation Center
UO_2	Uranium Dioxide

1.0 INTRODUCTION

This report describes the criticality analysis and results for the River Bend spent fuel racks with credit for NETCO-SNAP-IN® neutron absorbing inserts in each cell. No credit for the Boraflex neutron absorber is taken in this analysis. It includes sufficient detail on the methodology and analytical models utilized in the criticality analysis to verify that the storage rack systems have been accurately and conservatively represented. This analysis covers the current GNF2 and GNF3 fuel product lines and all legacy fuel stored in River Bend's spent fuel pool.

The racks are analyzed using the MCNP-05P Monte Carlo neutron transport program and ENDF/B-VII.0 cross-section library. The methodology used in this analysis is the peak cold in-core eigenvalue (k_∞) criterion methodology. A maximum cold, uncontrolled peak in-core k_∞ of 1.28 as defined by the lattice physics code TGBLA06 (Reference 1) is set as the limit for this analysis. As demonstrated in Table 1, the analysis resulted in a storage rack maximum k-effective (k_{max}(95/95)) less than 0.95 for normal and credible abnormal operation with tolerances and uncertainties taken into account.

Table 1 – Summary k_{max}(95/95) Result

Region	k_{max}(95/95)
Spent Fuel Rack with NETCO-SNAP-IN® Inserts	[[ ]]

2.0 REQUIREMENTS

Title 10 of the Code of Federal Regulations (CFR) Part 50 defines the requirements for the prevention of criticality in fuel storage and handling at nuclear power plants. 10 CFR 50.68 details specifically that the storage rack k_{max}(95/95) for spent fuel storage racks must be demonstrated to be $\leq$ 0.95 for normal and credible abnormal operation with tolerances and computational uncertainties taken into account. Reference 2 outlines the standards that must be met for these analyses. All necessary requirements are met in this analysis, including 10 CFR 50 Appendix A General Design Criterion 62. Nuclear Energy Institute (NEI) 12-16 (Reference 3) and Nuclear Regulatory Commission (NRC) Interim Staff Guidance DSS-ISG-2010-01 (Reference 4) are used as the guidance documents for this analysis.

3.0 METHOD OF ANALYSIS

In this evaluation, in-core k_∞ values and exposure dependent, pin-by-pin isotopic specifications are generated using the GE-Hitachi Nuclear Energy Americas LLC (GEH)/GNF lattice physics production code TGBLA06. TGBLA06 solves Two-Dimensional (2D) diffusion equations with diffusion parameters corrected by transport theory to provide system multiplication factors and perform burnup calculations.

The fuel storage criticality calculations are then performed using MCNP-05P, the GEH/GNF proprietary version of MCNP5 (Reference 5). MCNP-05P is a Monte Carlo program for solving the linear neutron transport equation for a fixed source or an eigenvalue problem. The code implements the Monte Carlo process for neutron, photon, electron, or coupled transport involving all these particles, and can compute the eigenvalue for neutron-multiplying systems. For the present application, only neutron transport was considered.

3.1 Cross-Sections

TGBLA06 uses ENDF/B-V cross-section data to perform coarse-mesh, broad-group, diffusion theory calculations. It includes thermal neutron scattering with hydrogen using an $S(\alpha,\beta)$ light water thermal scattering kernel.

MCNP-05P uses point-wise (i.e., continuous) cross-section data, and all reactions in a given cross-section evaluation (e.g., ENDF/B-VII.0) are considered. For the present work, thermal neutron scattering with hydrogen was described using an $S(\alpha,\beta)$ light water thermal scattering kernel. The cross-section tables include all details of the ENDF representations for neutron data. The code requires that all the cross-sections be given on a single union energy grid suitable for linear interpolation; however, the cross-section energy grid varies from isotope to isotope. The libraries include very little data thinning and utilize resonance integral reconstruction error tolerances of 0.001%.

3.2 Geometry Treatment

TGBLA06 is a 2D lattice design computer program for Boiling Water Reactor (BWR) fuel bundle analysis. It assumes that a lattice is uniform and infinite along the axial direction and that the lattice geometry and material are reflecting with respect to the lattice boundary along the transverse directions.

MCNP-05P implements a robust geometry representation that can correctly model complex components in three dimensions. An arbitrary three-dimensional configuration is treated as geometric cells bounded by first and second-degree surfaces and some special fourth-degree elliptical tori. The cells are described in a cartesian coordinate system and are defined by the intersections, unions and complements of the regions bounded by the surfaces. Surfaces are defined by supplying coefficients to the analytic surface equations or, for certain types of surfaces, known points on the surfaces. Rather than combining several pre-defined geometrical bodies in a combinatorial geometry scheme, MCNP-05P has the flexibility of defining geometrical shapes from all the first and second-degree surfaces of analytical geometry and elliptical tori and then combining them with Boolean operators. The code performs extensive checking for geometry errors and provides a plotting feature for examining the geometry and material assignments.

3.3 Convergence Checks

The use of TGBLA06 as a depletion code in this criticality analysis is consistent with its use for BWR fuel design and its associated user's manual. Convergence checks are encoded in the standard error routines and the absence of error messages was confirmed in all code output.

In this analysis, the following criticality code parameters were specified. At a minimum, all MCNP-05P cases were run with [[ ]] particles per cycle, [[ ]] cycles skipped and [[ ]] total cycles run. Some cases were run for more cycles skipped and more total cycles in order to meet all the converge checks. For this analysis, the following MCNP-05P convergence checks were reviewed and confirmed passed for each case:

- [[

]]

3.4 Validation and Computational Basis

[[

]]

Table 2 – Summary of the Critical Benchmark Experiments

Experiment	Experiments	Year	Where
[[			
			]]

Table 3 – Area of Applicability Covered by Code Validation

Parameters	Validation Area of Applicability	Spent Fuel Rack Characteristics
[[		
		]]

[[

]]

3.5 In-Core k_∞ Methodology

The design of the fuel storage racks provides for a subcritical multiplication factor for both normal and credible abnormal storage conditions. In all cases, the storage rack eigenvalue must be ≤ 0.95. To demonstrate compliance with this limit, the peak in-core k_∞ method is utilized.

The peak in-core k_∞ criterion method relies on a well-characterized relationship between infinite lattice k_∞ (in-core) for a given fuel design and a specific fuel storage rack k_∞ (in-rack) containing that fuel. The use of an infinite lattice k_∞ criterion for demonstrating compliance to fuel storage criticality criteria has been used for all GE-supplied storage racks and is currently used for re-rack designs at a number of plants. This report demonstrates that the methodology is also appropriate for use at the River Bend by presenting the following:

- A well-characterized, linear relationship between infinite lattice k_∞ (in-core) and fuel storage rack k_∞ (in-rack)
- The use of a design basis lattice with a conservative rack efficiency and in-core k_∞ for all criticality analyses

The analysis performed to calculate the lattice k_∞ to confirm compliance with the above criterion uses the NRC-approved lattice physics methods encoded into the TGBLA06 engineering computer program. One of the outputs of the TGBLA06 solution is the lattice k_∞ of a specific nuclear design for a given set of input state parameters (e.g., void fraction, control state, fuel temperature).

Compliance of fuel with specified k_∞ limits will be confirmed for each new lattice as part of the bundle design process. Documentation that this has been met will be contained in the fuel design information report, which defines the maximum lattice k_∞ for each assembly nuclear design. The process for validating that specific assembly designs are acceptable for storage in the River Bend fuel storage racks is provided below.

1. [[

]]

Documentation that all legacy fuel types currently in the River Bend comply with this in-core limit is found in Appendix B.

3.6 Definitions

Fuel Assembly – is a complete fuel unit consisting of a basic fuel rod structure that may include large central water rods. Several shorter rods may be included in the assembly. These are called "part-length rods". A fuel assembly includes the fuel channel.

Gadolinia – The compound Gd_2O_3. The gadolinium content in integral burnable absorber fuel rods is usually expressed in weight percentage gadolinia.

Lattice – An axial zone of a fuel assembly within which the nuclear characteristics of the individual rods are unchanged.

Dominant Lattice – An axial zone of a fuel assembly typically located in the bottom half of the bundle within which all possible fuel rod locations for a given fuel design are occupied.

Mid Lattice – [[

]]

Vanished Lattice – An axial zone of a fuel assembly typically in the upper half of the bundle within which a number of possible fuel rod locations are unoccupied.

Rack Efficiency – the ratio of a particular lattice statepoint in-rack eigenvalue (k_∞) to its associated lattice nominal in-core eigenvalue (k_∞). This value allows for a straightforward comparison of a rack's criticality response to varying lattice designs within a particular fuel product line. A lower rack efficiency implies increased reactivity suppression capability relative to an alternate design with a higher rack efficiency.

Design Basis Lattice – The lattice geometry, exposure history, and corresponding fuel isotopics for a fuel product line that result in the highest rack efficiency in a sensitivity study of reasonable fuel parameters at the desired in-core reactivity. This lattice is used for all normal, abnormal, and tolerance evaluations in the fuel rack analysis.

3.7 Assumptions and Conservatisms

The fuel storage rack criticality calculations are performed with the following assumptions to ensure the true system reactivity is always less than the calculated reactivity:

- [[

  ]]

- For conservatism, only positive reactivity differences from nominal conditions determined from depletion sensitivity and abnormal configuration, analyses are added as biases to the final storage rack k_{max}(95/95).
- Neutron absorption in spacer grids, concrete, activated corrosion and wear products (CRUD) and axial blankets is ignored to limit parasitic losses in non-fuel materials.
- TGBLA06 defined "lumped fission products" and Xe-135 are both conservatively ignored for MCNP-05P in-rack k_{∞} calculations.
- [[

]]

- The chevron shaped rack inserts are installed with multiple wing lengths to allow for improved fitting within the rack structure. The minimum designed wing length for these inserts is [[ ]] inches from a nominal [[ ]] inches. This length does not include the insert material which is bent at a 90-degree angle at the end of each wing. Including this material, the total unbent insert length is greater than [[ ]] inches. Each wing is modeled at a wing length of [[ ]] inches to represent all inserts in the rack which is an equivalent [[ ]] inches total unbent insert length. Because the analysis models less material than is actually present in the insert, this approach is conservative. Modeling the inserts in this way minimizes thermal neutron absorptions in the inserts.
- Only B^{10} is modeled in the rack inserts. The minimum certified areal density is 0.0129 g B^{10}/cm^2. Each insert is assumed to contain an areal density of 0.0115 g B^{10}/cm^2. All other material is ignored. Ignoring the other materials conservatively limits neutron absorption in the insert.
- No credit is taken for the Boraflex in the storage racks in the analysis, and all material between the inner cell wall and outer wrapper of the fuel rack is modeled as water. Modeling this material as water is reasonable, as the outer wrapper does not provide a water tight seal between the Boraflex and pool environment, and therefore any significant gap formations within the poison material will be filled with water.

4.0 FUEL DESIGN BASIS

This rack criticality analysis covers all legacy fuel in River Bend, the current fuel product line in River Bend, GNF2, and planned future fuel, GNF3. The disposition for all legacy fuel is in Appendix B. The description of current and future fuel product lines, GNF2 and GNF3, are found in Sections 4.1 and 4.2. Both these product lines are used to determine the design basis bundle in Section 5.3.

All fuel is UO_2 with some fuel rods containing gadolinia, Gd_2O_3.

This criticality analysis covers reconstituted fuel where a rod containing fuel is replaced with another fueled or non-fueled rod. This analysis does not cover reconstituted fuel where there are missing rod locations that are not part of the normal fuel product line design.

This criticality analysis also covers the storage of non-fuel items such as channels in spent fuel rack locations because this analysis covers peak reactivity fuel in every rack cell location.

4.1 GNF2 Fuel Description

Criticality safety analyses to determine storage system reactivity are performed using the GNF2 fuel design. The GNF2 fuel lattice configuration is a 10x10 fuel rod array minus eight fuel rods that have been replaced with two large water rods, as shown in Figure 1 with corresponding dimensions in Table 4. The references in Table 4 corresponding to Figure 1. Figure 1 also demonstrates the part-length rod locations, which cannot be changed for this fuel design. Fuel channel dimensions are provided in Figure 2 and Table 5. Pellet stack density is in Table 6.

[[

]]

[[

]]

Figure 1 – GNF2 Fuel Lattice Configuration

Table 4 – Nominal Dimensions for GNF2 Fuel Lattice

Features	Reference	(mm)	(inches)
[[			
			]]

[[

]]

Figure 2 – Channel Dimensions

Table 5 – Nominal Channel Dimensions for GNF2 Lattice

Dimension	mm	inches
[[		
		]]

Table 6 – Fuel Stack Density as a Function of Gadolinia Concentration

[[								
								]]

[[

]]

4.2 GNF3 Fuel Description

The GNF3 fuel lattice configuration is a 10x10 fuel rod array [[ ]], as shown in Figure 3 with corresponding dimensions in Table 7 and Table 8. Figure 3 also demonstrates the part-length rod locations. Fuel channel dimensions are provided in Figure 4 and Table 9. Pellet stack density is in Table 6. [[ ]]

[[

]]

Figure 3 - GNF3 Lattice Configuration

Table 7 - Lattice Dimensions

Item			Dimension	
			mm	in
[[				
				]]

Table 8 - Cell Dimensions

Lattice Type	Channel Name	½ Wide Gap, Q		½ Narrow Gap, R		Control Blade Pitch, S	
		mm	in	mm	in	mm	in
[[							]]

[[

]]

Figure 4 - Channel 1/8 Cross-Sections

Table 9 - Channel Dimensions

Channel Name		93AV			
Channel Section		Zone 1		Zone 2	
Dimension		mm	in	mm	in
[[					
					]]

4.3 Fuel Model Description

The fuel models considered include 2D geometric modeling of all fuel material, cladding, water rods, and channels. [[

]] An example of a GNF3 mid lattice model in MCNP-05P (Case 4 from Table 11) is depicted in Figure 5. The black pins are the gadolinia rods. The control blade corner would be in the upper left corner.

[[

]]

Figure 5 – GNF3 Lattice in MCNP-05P

[[

]] The lattice type and exposure history that results in the worst-case rack efficiency for an in-core k_∞ greater than the proposed limit is then used to define the design basis lattice. This lattice is assumed to be stored in every location in the rack being analyzed. Details on the determination of the design basis lattice using the process outlined above are presented in Section 5.3.

5.0 CRITICALITY ANALYSIS OF SPENT FUEL STORAGE RACKS

5.1 Description of Spent Fuel Storage Racks

The River Bend Boraflex storage racks manufactured by Westinghouse consist of a 304 SS structure composed of a series of square vertical tubes (cells). These tubes contain 0.078" thick Boraflex panels sandwiched between a 0.075" SS inner cell wall and a 0.035" SS outer wrapper. The Boraflex containing cells are arranged in a checkerboard pattern with the space between a 4-cell group forming a fifth bundle storage location with a center-to-center cell pitch of 6.280 inches. Rack arrays are placed adjacent to one another in the spent fuel pool. A schematic of a single storage rack unit-cell without inserts installed is shown in Figure 6.

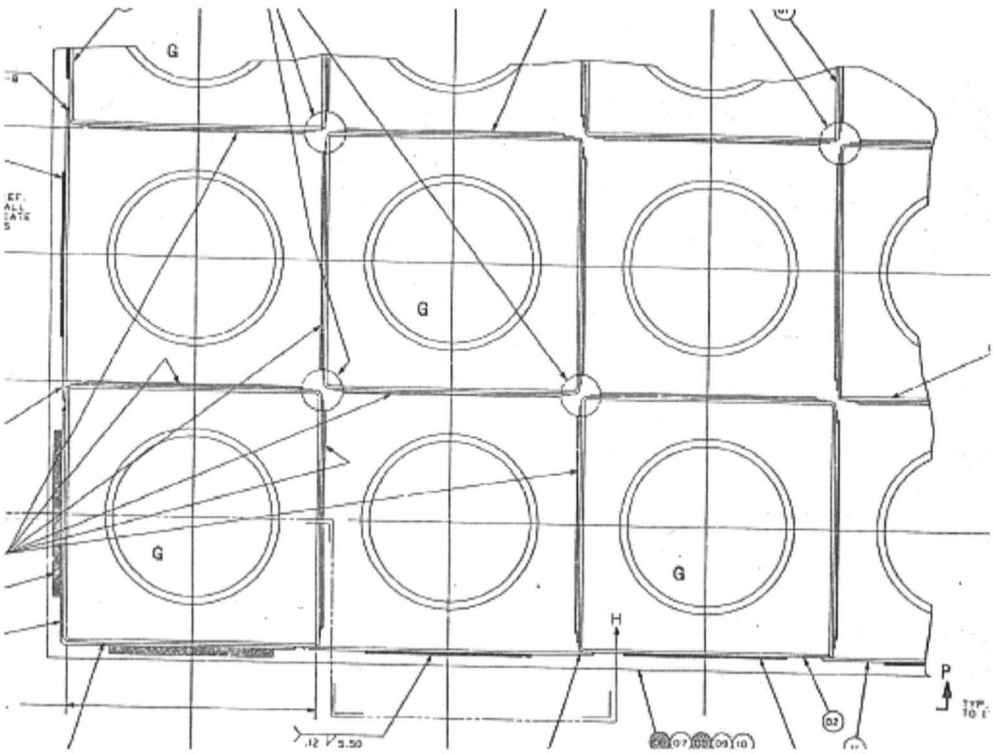

Figure 6 – Boraflex Spent Fuel Storage Rack Cell

Originally, the racks employed thermal neutron absorption in the B^{10} of the Boraflex as the primary mechanism of reactivity control; however, the Boraflex has been demonstrated to be degrading over time. Therefore, no credit is taken for the Boraflex in this analysis, and all material between the inner cell wall and outer wrapper is modeled as water. Modeling this material as water is reasonable, as the outer wrapper does not provide a water tight seal between the Boraflex and pool environment. Therefore, any significant gap formations within the poison material will be filled with water.

To supplement the reactivity suppression capability of the rack, chevron shaped neutron absorbing inserts (NETCO-SNAP-IN®) are installed in each of the storage cells in a storage rack module. These inserts extend over the full-length of the active fuel region of the stored assemblies. The inserts are manufactured from a Rio Tinto Alcan aluminum boron carbide metal matrix composite with a minimum certified areal density of 0.0129 g B^{10}/cm^2. In this analysis, a lower B^{10} areal density of 0.0115 g B^{10}/cm^2 was used in the base model. The minimum designed wing length for these inserts is [[ ]] inches. This length does not include the insert material which is bent at a 90-degree angle at the end of each wing. Including this material, the total unbent insert length is greater than [[ ]] inches. For simplicity, each wing is modeled with a [[ ]] wing length to conservatively represent all inserts in the rack. Each insert is installed with the same orientation. In this way, one leg of an insert exists between each bundle in the storage rack assembly. A general schematic demonstrating this layout is provided in Figure 7.

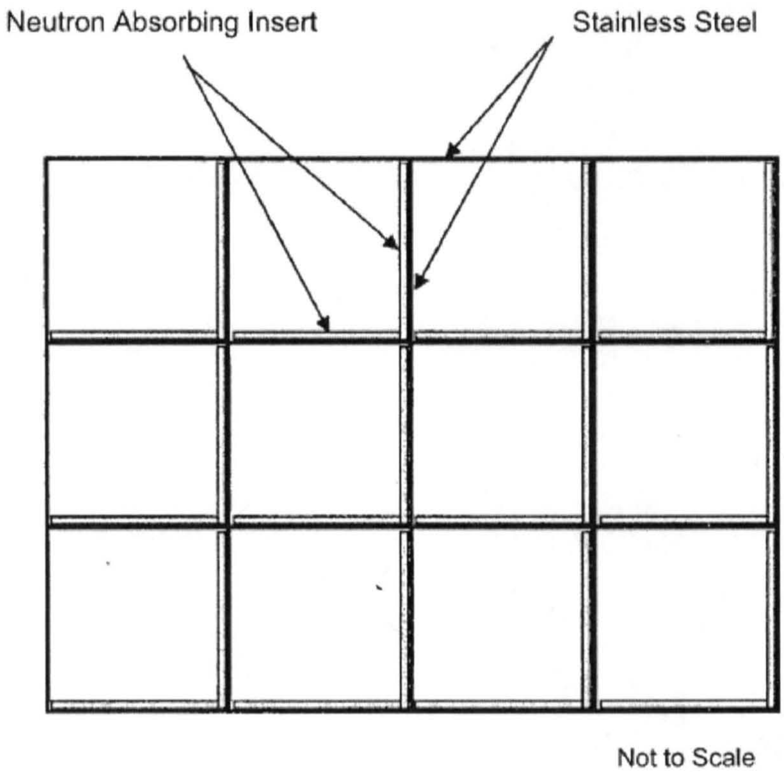

Figure 7 – Storage Rack Array with Inserts

Based on the insert configuration, peripheral storage cells on two sides of the storage pools will not be surrounded by four wings of the absorbing insert. The reactivity effect of this storage limitation will be assessed in Section 5.5.

5.2 Spent Fuel Storage Rack Models

This analysis covers a single bounding storage configuration of maximum reactivity fuel in every storage location with a NETCO-SNAP-IN® insert in every storage location.

A 2D infinite storage array with periodic boundary conditions is modeled to conservatively represent the nominal spent fuel pool configuration. An image of a single element of the model is provided in Figure 8 and a zoomed in view of Figure 9, with dimensions and tolerances presented in Table 10. This single element is used to define a 10x10 rack array with periodic boundary conditions. This array is used in the design basis bundle selection process in Section 5.3.

MCNP-05P initial source distribution is defined as [[ ]]

[[

]]

Figure 8 – Storage Rack Model Schematic

[[

]]

Figure 9 – Zoomed Storage Rack Model Schematic

Table 10 – Storage Rack Model Dimensions

		Tolerances	
Rack Model Parameter	**Nominal**	**Plus**	**Minus**
	(inches)	*(inches)*	*(inches)*
Rack Pitch	6.280	0.060	0.060
Inner Cell Wall Thickness	0.075	None	None
Outer Wrapper Thickness	0.035	None	None
Boraflex Thickness	0.078	0.010	0.010
Boraflex Width	5.100	0.075	0.075
Primary Fuel Box Inner Width	6.050	0.025	0.025
Resultant Fuel Box Inner Width	6.110	None	None
[[			
			]]

[[ ]] See Section 3.7 for modeling assumptions.

5.3 Design Basis Lattice Selection

Table 11 defines the lattice designs and exposure histories that were explicitly studied in the spent fuel storage rack to determine the geometric configuration and isotopic composition that results in the worst rack efficiency. Note that void state is not a relevant parameter for zero exposure peak reactivity cases, and, therefore, only a single result is presented for these fuel loadings. Figure 10 presents a graph that demonstrates the linear nature of the in-core to in-rack results over all rack efficiency cases studied in the rack system. [[

]] The highest rack efficiency with an in-core k_∞ greater than the proposed limit of 1.28 is found to result from the parameters defined in Table 11 Case 4. The geometry and isotopics defined for this case are used to define all bundles in the remaining spent fuel rack analyses.

Table 11 – Fuel Parameter Ranges Studied in Spent Fuel Rack

Case	Lattice Type	Void	Average Lattice Enrichment (U-235 wt.%)	Number of Gadolinia Rods	Gadolinia Concentration (Gd wt. %)	Peak-Reactivity Exposure (GWD/ST)	TGBLA06 Defined In-Core k_∞	MCNP-05P Defined In-Rack k_∞	Rack Efficiency
[[									

Case	Lattice Type	Void	Average Lattice Enrichment (U-235 wt.%)	Number of Gadolinia Rods	Gadolinia Concentration (Gd wt. %)	Peak-Reactivity Exposure (GWD/ST)	TGBLA06 Defined In-Core k_∞	MCNP-05P Defined In-Rack k_∞	Rack Efficiency
									]]

[[

]]

Figure 10 – Spent Fuel In-Core vs. In-Rack Eigenvalues

5.4 Normal Configuration Analysis

5.4.1 Analytical Models

The most reactive normal configuration was determined by studying the reactivity effect of the following credible normal scenarios:

- [[

]]

5.4.2 Results

The results of the study are provided in Table 12. [[

]] The in-rack k_∞ associated with this nominal combination of conditions is [[ ]], and is hereafter referred to as k_{Normal}. This configuration will be used for all abnormal and tolerance studies that are performed on an infinite basis. Any small, positive reactivity differences from this nominal condition are included in the calculation of the system bias in Section 5.5.2.

Table 12 – Spent Fuel Storage Rack In-Rack k_∞ Results – Normal Configurations

Term	Configuration	In-Rack k_∞	MCNP-05P Uncertainty (1σ)
[[			
			]]

* Largest positive reactivity increase from nominal case for each term is included in roll-up of Δk_{Bias}

5.5 Bias Cases

5.5.1 Depletion Bias Cases

The following configurations related to the depletion conditions of the stored bundles were explicitly considered, where each description defines a condition all bundles in storage experience over their entire exposure histories. These bound the conditions the bundles actually experience.

- [[

]]

The following potential reactivity effect of changes that occur during depletion are considered:

a. Fuel rod changes (clad creep, fuel densification/swelling)

   [[

   ]]

b. Material dependent grid growth

   [[

   ]]

5.5.2 Normal Bias Cases

The following bias cases are included for normal conditions. As seen in Table 12, [[

]] and are therefore included in Table 17.

- No inserts on rack periphery

  [[

  ]]

Table 13 – Rack Periphery Study Results

Description	k_{eff}	MCNP-05P Uncertainty (1σ)	Δk
[[			
			]]

- Missing rack insert

  A missing insert from the 10x10 infinite array was analyzed to cover the periodic removal of an insert for inspection or an insert being accidently removed during fuel movement. The relative reactivity increase from this condition is included in the bias table in Table 17.

- Fuel out of rack during normal fuel handling/inspections

  Several fuel assembly geometric configurations are possible in the fuel pool and fuel transfer area during fuel handling activities such as fuel stored in the fuel prep machines. [[

]]

5.5.3 Abnormal/Accident Bias Cases

Additionally, perturbations of the normal spent fuel rack configuration were considered for credible accident scenarios. The scenarios considered are presented in the bulleted lists that follow, with explanations of the abnormal condition provided below each listing of similar configurations. The most limiting of these abnormal/accident conditions is included in the final Δk_{Bias} term in Table 17.

- Dropped/damaged fuel

  [[

  ]]

- Abnormal positioning of a fuel assembly outside the fuel storage rack

  [[

  ]]

[[

]]

Figure 11 – Finite Misplaced Bundle Model Example

Table 14 – Misplaced Assembly Results

Description	k_{eff}	MCNP-05P Uncertainty (1σ)	Δk
[[			
			]]

- Abnormal positioning of a fuel assembly in defective fuel storage location

  [[

]]

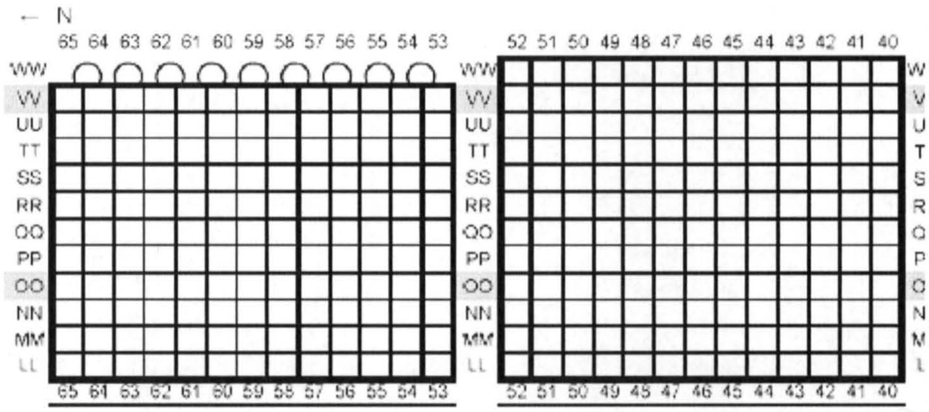

Figure 12 – SFP Rack Defective Fuel Storage Canister Locations

[[

]]

Figure 13 – Misplaced Bundle in a Defective Fuel Storage Location

Table 15 – Results for a Misplaced Bundle in a Defective Fuel Storage Location

Description	k_{eff}	MCNP-05P Uncertainty (1σ)	Δk
[[			
			]]

The following abnormal configurations are also considered bounded, with the justification provided:

- Dropped bundle on rack

  Justification – For a drop on the rack, the fuel assembly will come to rest horizontally on top of the rack with a minimum separation distance from the fuel in the rack of more than 12 inches. At this separation distance, the fissile material will be separated by enough neutron mean free paths to preclude neutron interactions that increase k_{eff}, and the overall effect on reactivity will be insignificant. Therefore, no case was performed for this analysis consistent with NEI 12-16 (Reference 3).

- Rack Sliding due to seismic event which causes water gap between racks to close

  Justification – The racks modeled in this analysis are infinite in extent with no inter-module water gaps. This essentially assumes all racks are close-fitting and bounds possible reactivity effects of rack sliding.

- Loss of Spent Fuel Pool Cooling

  Justification – [[

  ]]

Table 16 – Spent Fuel Storage Rack Abnormal Bias Summary

Description	k_{eff}	MCNP-05P Uncertainty (1σ)	Δk	Δk Uncertainty (2σ)
[[				
				]]

[[

]]

5.5.4 Results

The results of the abnormal studies are provided in Table 17. [[

]] The total contribution from these independent conditions to the k_{max}(95/95) of the spent fuel rack is calculated using Equation 1. In this equation, a Δk_{Bi} value must be both positive and the largest for its respective term to be considered.

$$\Delta k_{Bias} = \sum_{i=1}^{n} \Delta k_{Bi} \qquad (1)$$

Table 17 – Spent Fuel Storage Rack Bias Summary

Term	Description	k_{eff}	MCNP-05P Uncertainty (1σ)	Δk	Δk Uncertainty (2σ)
[[					
					]]

[[

]]

5.6 Tolerance Analysis

5.6.1 Analytic Models

The following tolerance study configurations were explicitly considered for the spent fuel rack:

- [[ ]]
- Rack pitch decrease by 0.06 inches
- Rack pitch increase by 0.06 inches
- [[ ]]

All the tolerances used in these analyses are at least 2σ design limits. The models developed for these studies were all based on the normal configuration presented in Section 5.4.

There was no manufacturing tolerance specified for the rack wall thickness; therefore, no tolerance case was performed for rack wall thickness.

The inner width tolerance case is covered by the rack pitch tolerance case because the rack pitch tolerance bounds the inner cell width tolerance. Because there is no tolerance on the rack wall thickness, the only way to change the inner box width is by changing the pitch.

Because the Boraflex is modeled as water in this analysis, no tolerance cases are performed on the Boraflex thickness or width.

5.6.2 Results

The results of the tolerance studies are provided in Table 18. The Δk term in this table represents the difference between the system reactivity with the specified tolerance perturbation and k_{Normal}. The total contribution from these independent tolerances to the $k_{max}(95/95)$ of the spent fuel rack is calculated using Equation 2. In this equation, a Δk_{Ti} value must be both positive and the largest for its respective term to be considered.

$$\Delta k_{Tolerances} = \sqrt{\sum_{i=1}^{n} \Delta k_{Ti}^{2}} \qquad (2)$$

Table 18 – Spent Fuel Storage Rack Tolerance Configuration Δk Results

Term	Description	k_{eff}	MCNP-05P Uncertainty (1σ)	Δk*	Δk Uncertainty (2σ)
[[					
					]]

[[

]]

5.7 Uncertainty Values

The total contribution to the $k_{max}(95/95)$ of the spent fuel rack from the problem and code specific uncertainties is calculated using Equation 3 and the values in Table 19.

$$\Delta k_{Uncertainty} = \sqrt{\sum_{i=1}^{n} \Delta k_{Ui}^2} \quad (3)$$

Table 19 – Spent Fuel Storage Rack Uncertainty Δk Values

Term	Description	Value
[[		
		]]

5.8 Maximum Reactivity

The maximum reactivity of the spent fuel rack without crediting Boraflex and with rack inserts installed, considering all biases, tolerances, uncertainties, and administrative margin, is calculated using Equation 4. The final values are presented in Table 20. The administrative margin bias is margin to be considered by the NRC to offset any concerns with the methods used in this analysis. Margin to the regulatory limit in excess of this administrative margin may be used by Entergy in the 10 CFR 50.59 analysis for future requirements.

$$k_{\max(95/95)} = k_{Normal} + \Delta k_{Bias} + \Delta k_{Tolerance} + \Delta k_{Uncertainty} + \Delta k_{Admin\ Margin} \quad (4)$$

Table 20 – Spent Fuel Storage Rack Results Summary

Term	Value
[[	
	]]

6.0 INTERFACES BETWEEN AREAS WITH DIFFERENT STORAGE CONDITIONS

The River Bend spent fuel pool contains only one rack type, Boraflex racks, so there is no interface between dissimilar racks. The River Bend spent fuel pool is a uniform pool with only one storage configuration with inserts installed in every location uniformly. There are no interfaces to consider for different storage conditions. There are no interface restrictions.

7.0 CONCLUSIONS

The River Bend spent fuel racks have been analyzed for the storage of GNF2 and GNF3 fuel using the MCNP-05P Monte Carlo neutron transport program and the k_∞ criterion methodology. A maximum cold, uncontrolled peak in-core eigenvalue (k_∞) of 1.28 as defined by TGBLA06 is specified as the rack design limit for GNF2 and GNF3 fuel in the spent fuel racks with NETCO-SNAP-IN® rack inserts installed. The analyses resulted in a storage rack maximum k-effective (k_{max}(95/95)) less than the 10 CFR 50.68 limit 0.95 for normal and credible abnormal operation with tolerances and computational uncertainties taken into account. Documentation that all legacy River Bend fuel types meet the k_{max}(95/95) limit is found in Appendix B.

8.0 REFERENCES

1. General Electric Company, "Steady-State Nuclear Methods," NEDE-30130-P-A, April 1985.

2. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 9.1.1, "Criticality Safety of Fresh and Spent Fuel Storage and Handling," US NRC, Revision 3, March 2007. (NRC ADAMS Accession Number ML070570006).

3. NEI 12-16 Revision 3, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants," March 2018. (NRC ADAMS Accession Number ML18088B400).

4. DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools," US NRC, September 2011. (NRC ADAMS Accession Number ML110620086).

5. LA-UR-03-1987, "MCNP – A General Monte Carlo N-Particle Transport Code, Version 5," April 2003.

6. NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," US NRC, January 2001. (NRC ADAMS Accession Number ML050250061).

7. J.R. Taylor, "An Introduction to Error Analysis," page 268-271, 2nd Edition, University Science Books, 1997.

APPENDIX A - MCNP-05P CODE VALIDATION

Table 21 presents the results of the benchmark calculations described in Section 3.4. Note that it is necessary to make an adjustment to the calculated k_{eff} value if the critical experiment being modeled was not at a critical state. This adjustment is done by normalizing the k_{calc} values to the experimental values, which is valid for small differences in k_{eff}. This normalization is reported as k_{norm} and is determined using Equation A-1. The combined uncertainty from the measurement and the calculation (σ_t) is also determined using Equation A-2.

$$k_{norm} = k_{calc}/k_{exp} \qquad \text{(A-1)}$$

$$\sigma_t = \sqrt{\sigma_{calc}^2 + \sigma_{exp}^2} \qquad \text{(A-2)}$$

Table 21 – MCNP-05P Results for the Benchmark Calculations

#	Experiment	Expt. #	Benchmark Eigenvalue (k_{exp})	Experimental Uncertainty (σ_{exp})	MCNP-05P Result (k_{calc})	MCNP-05P Uncertainty (σ_{calc})	Norm. Result (k_{norm})	Combined Uncertainty (σ_t)
[[								

#	Experiment	Expt. #	Benchmark Eigenvalue (k_{exp})	Experimental Uncertainty (σ_{exp})	MCNP-05P Result (k_{calc})	MCNP-05P Uncertainty (σ_{calc})	Norm. Result (k_{norm})	Combined Uncertainty (σ_t)

#	Experiment	Expt. #	Benchmark Eigenvalue (k_{exp})	Experimental Uncertainty (σ_{exp})	MCNP-05P Result (k_{calc})	MCNP-05P Uncertainty (σ_{calc})	Norm. Result (k_{norm})	Combined Uncertainty (σ_t)

#	Experiment	Expt. #	Benchmark Eigenvalue (k_{exp})	Experimental Uncertainty (σ_{exp})	MCNP-05P Result (k_{calc})	MCNP-05P Uncertainty (σ_{calc})	Norm. Result (k_{norm})	Combined Uncertainty (σ_t)

#	Experiment	Expt. #	Benchmark Eigenvalue (k_{exp})	Experimental Uncertainty (σ_{exp})	MCNP-05P Result (k_{calc})	MCNP-05P Uncertainty (σ_{calc})	Norm. Result (k_{norm})	Combined Uncertainty (σ_t)
								]]

A.1 - Trend Analysis

To determine if any trend is evident in this pool of experiments, the parameters listed in Table 22 were considered as independent variables.

Table 22 – Trending Parameters

Energy of the Average Lethargy causing Fission (EALF)
Uranium Enrichment (wt.% U-235)
Plutonium Content (wt.% Pu-239)
Atom ratio of hydrogen to fissile material (H/X)

Each parameter was plotted against the k_{norm} results independently for each case that was analyzed. These plots are provided in Figure 14 through Figure 17. This scatter plot of data was first analyzed by visual inspection to determine if any trends were readily apparent in the data. During this inspection, the axes of the graphs were modified to different scales to allow for a more thorough review. No clear evidence of a trend, linear or otherwise, was observed from this inspection.

[[

]]

Figure 14 – Scatterplot of EALF versus k_{norm}

[[

]]

Figure 15 – Scatterplot of wt.% U-235 versus k_{norm}

[[

]]

Figure 16 – Scatterplot of wt.% Pu-239 versus k_{norm}

[[

]]

Figure 17 – Scatterplot of H/X versus k_{norm}

To further check for trends in the data, a linear regression was performed. The linear regression fitted equation is in the form y(x)= a +bx, where y is the dependent variable (k_{calc}) and x is any of the predictor variables from Table 22. Unweighted k_{calc} values were used in this evaluation, though it is noted that, due to the very similar σ_{calc} values reported in Table 21, using weighted values would produce very similar results. This regression was performed using the built-in regression analysis tool in Excel. The fitted lines are included in Figure 14 through Figure 17. Again, it is noted through visual inspection that the trends do not appear to exhibit a strong correlation to the data. A useful tool to validate this claim is the linear correlation coefficient. This is a quantitative measure of the degree to which a linear relation exists between two variables. It is often expressed as the square term, r^2, and can be calculated directly using built in functions in Excel. The closer r^2 gets to the value of 1, the better the fit of data is expected to be to the linear equation. Results from this linear regression evaluation are summarized in Table 23.

A final method to test for goodness of fit is the chi squared test (χ^2). This method is explained in detail in Reference 7. In general, it can be stated that χ^2 is an indicator of the agreement between the observed (calculated) and expected (fitted) values for some variable. For linear goodness of fit testing using this method, Equation A-3 is utilized, where the expected value of $f(x_i)$ corresponds to the linear fitted equation for the trending parameter, x_i.

$$\chi^2 = \sum_1^N \left(\frac{k_{calc^i} - f(x_i)}{\sigma_{calc^i}}\right)^2 \qquad \text{(A-3)}$$

A more convenient way to report this result is the reduced chi squared value, which is denoted as $\tilde{\chi}^2$ and is defined by Equation A-4, where d is the degrees of freedom for the evaluation.

$$\tilde{\chi}^2 = \chi^2/d \qquad \text{(A-4)}$$

If a value of order one or less is obtained for this equation, then there is no reason to doubt the expected (fitted) distribution is reasonable; however, if the value is much larger than one, the expected distribution is unlikely to be a good fit. Results for each trending parameter are summarized in Table 23.

Table 23 – Trending Results Summary

Trend Parameter	Intercept	Slope	r^2	$\tilde{\chi}^2$	Valid Trend
H/X	[[				No
U-235 wt.%					No
EALF					No
Pu-239 wt.%				]]	No

The results in Table 23 clearly demonstrate that there are no statistically significant or valid trends of k_{norm} with any of the trending parameters.

A.2 - Bias and Bias Uncertainty Calculation – Single Sided Tolerance Limit

As no trends are apparent in the critical experiment results, a weighted single-sided tolerance limit methodology is utilized to establish the bias and bias uncertainty for this AOA and code package combination. Use of this method requires the critical experiment results to have a normal statistical distribution. This was verified using the Anderson-Darling normality test. A graphical image of the results for this normality test, including the p-value for the distribution, is provided in Figure 18. Because the reported p-value is greater than 0.05, it is confirmed that the data fits a normal distribution, and the single sided tolerance limit methodology is confirmed to be applicable.

[[

]]

Figure 18 – Normality Test of k_{norm} Results

When using this method, the weighted bias and bias uncertainty are calculated using the following equations:

$$Bias = \bar{k}_{norm} - 1 \tag{A-5}$$

$$Bias\ Uncertainty = U \cdot S_p \tag{A-6}$$

$$\bar{k}_{norm} = \frac{\sum_{i=1}^{n} \frac{k_{norm_i}}{\sigma_t^2}}{\sum_{i=1}^{n} \frac{1}{\sigma_t^2}} \tag{A-7}$$

$$S_P = \sqrt{s^2 + \overline{\sigma}^2} \tag{A-8}$$

$$\overline{\sigma}^2 = \frac{n}{\sum_{i=1}^{n} \frac{1}{\sigma_i^2}} \tag{A-9}$$

$$s^2 = \frac{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n} \frac{1}{\sigma_i^2}\left(k_{norm\,i} - \overline{k}_{norm}\right)^2}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{\sigma_i^2}} \tag{A-10}$$

where:

$\overline{k}_{norm}$ = Average weighted k_{norm}

S_P = Pooled standard deviation

s^2 = Variance about the mean

$\overline{\sigma}^2$ = Average total variance

U = one-sided tolerance factor for n data points at (95/95 confidence/probability level)

n = number of data points (= [[ ]])

Table 24 summarizes the results of these calculations.

Table 24 - Bias and Bias Uncertainty for MCNP-05P with ENDF/B-VII

Bias (weighted)	[[
Bias Uncertainty (95/95 level)	
Variance About the Mean	
Average Total Variance	
Pooled Standard Deviation (1σ)	
One-Sided Tolerance Factor	]]

Using the average weighted bias and pooled standard deviation; the upper one-sided 95/95-tolerance limit (bias uncertainty) was calculated for use in criticality calculations, in accordance with NUREG/CR-6698 guidance (Reference 6). [[

]] Table 25 summarizes the recommended bias and bias uncertainty to be used in criticality calculations.

Table 25 – Recommended Bias and Bias Uncertainty in Criticality Analyses for MCNP-05P with ENDF/B-VII

Bias	[[
Bias Uncertainty (95/95)	]]

APPENDIX B - LEGACY FUEL STORAGE JUSTIFICATION

Exposure dependent, maximum, uncontrolled in-core k_∞ results have been calculated for each fuel assembly in the River Bend spent fuel pools and are confirmed to be less than 1.28. The in-core k_∞ values have been calculated using the process for validating that specific assembly designs are acceptable for storage in the River Bend fuel storage racks, as outlined in Section 3.5. The margin to safety was also confirmed to exist in the storage rack by analyzing the peak reactivity legacy fuel lattice of each product line under normal conditions of storage, as outlined in Section 5.4 and the in-rack reactivity values are presented in Table 26. This information demonstrates that all fuel assemblies currently in the River Bend spent fuel pools have considerable margin to the reactivity of the GNF3 design basis bundle used in this analysis. All GNF2 and GNF3 bundles in River Bend's core or spent fuel pool are covered by the design basis bundle study in Section 5.3.

Because the GNF3 design basis bundle with an in-core k_∞ value of 1.28 has been shown to be below the 10 CFR 50.68 0.95 in-rack limit when analyzed in the storage racks, and because the legacy fuel types are less reactive than this design basis bundle both in-core and in-rack, it is confirmed that all legacy fuel bundles are safe for storage in the River Bend spent fuel storage racks with rack inserts installed.

Table 26 – Peak Cold Uncontrolled In-Rack Reactivity for Legacy Fuel Types

Fuel Product Line	In-Rack Nominal Reactivity
[[	
	]]

ATTACHMENT 4
RBG-47900

NEI 12-16 CRITICALITY ANALYSIS CHECKLIST

CRITICALITY ANALYSIS CHECKLIST

The criticality analysis checklist is completed by the applicant prior to submittal to the NRC. It provides a useful guide to the applicant to ensure that all the applicable subject areas are addressed in the application, or to provide justification/identification of alternative approaches.

The checklist also assists the NRC reviewer in identifying areas of the analysis that conform or do not conform to the guidance in NEI 12-16. Subsequently, the NRC review can then be more efficiently focused on those areas that deviate from NEI 12-16 and the justification for those deviations.

Subject	Included	Notes / Explanation
1.0 Introduction and Overview		
Purpose of submittal	YES	
Changes requested	YES	
Summary of physical changes	YES	
Summary of Tech Spec changes	YES	Section 2.4 of Enclosure 1
Summary of analytical scope	YES	
2.0 Acceptance Criteria and Regulatory Guidance		
Summary of requirements and guidance	YES	
Requirements documents referenced	YES	
Guidance documents referenced	YES	
Acceptance criteria described	YES	
3.0 Reactor and Fuel Design Description		
Describe reactor operating parameters	NO	See Section 5.5.1 of Attachment 7 for discussion.
Describe all fuel in pool	YES	Section 4.1 of Attachment 7 and Appendix B
Geometric dimensions (Nominal and Tolerances)	YES	Section 4.1 of Attachment 7
Schematic of guide tube patterns	YES	Water rod locations described in Section 4.1 of Attachment 7. Guide tube patterns not applicable for BWR fuel.
Material compositions	YES	Section 4.0 of Attachment 7
Describe future fuel to be covered	YES	Section 4.2 of Attachment 7
Geometric dimensions (Nominal and Tolerances)	YES	Section 4.2 of Attachment 7
Schematic of guide tube patterns	YES	Water rod locations described in Section 4.2 of Attachment 7. Guide tube patterns not applicable for BWR fuel.
Material compositions	YES	Section 4.0 of Attachment 7

Subject	Included	Notes / Explanation
Describe all fuel inserts	NO	There are no fuel inserts in this analysis.
Geometric Dimensions (Nominal and Tolerances)		
Schematic (axial/cross-section)		
Material compositions		
Describe non-standard fuel	YES	Section 4.0 of Attachment 7
Geometric dimensions		
Describe non-fuel items in fuel cells	YES	Section 4.0 of Attachment 7 describes channel dimensions.
Nominal and tolerance dimensions	NO	Not applicable
4.0 Spent Fuel Pool/Storage Rack Description		
New fuel vault & Storage rack description	NO	See Section 2.3 of Enclosure 1. The proposed change does not include the new fuel storage racks.
Nominal and tolerance dimensions		
Schematic (axial/cross-section)		
Material compositions		
Spent fuel pool, Storage rack description	YES	Section 5.1-5.2 of Attachment 7. The proposed change does not include the containment pool spent fuel storage racks (Section 2.3 of Enclosure 1).
Nominal and tolerance dimensions		
Schematic (axial/cross-section)		
Material compositions		
Other Reactivity Control Devices (Inserts)	YES	Section 5.1-5.2 of Attachment 7
Nominal and tolerance dimensions		
Schematic (axial/cross-section)		
Material compositions		
5.0 Overview of the Method of Analysis		
New fuel rack analysis description	NO	See Section 2.3 of Enclosure 1. The proposed change does not include the new fuel storage racks.
Storage geometries		
Bounding assembly design(s)		
Integral absorber credit		
Accident analysis		
Spent fuel storage rack analysis description	YES	Section 5.0 and Section 3.5-3.7 of Attachment 7
Storage geometries	YES	Section 5.2 of Attachment 7
Bounding assembly design(s)	YES	Section 5.3 of Attachment 7
Soluble boron credit	NO	Not applicable - No soluble boron is used at RBS.
Boron dilution analysis		
Burnup credit	NO	No burnup credit in BWR peak reactivity analysis – fuel is evaluated at peak reactivity.
Decay/Cooling time credit	NO	No decay/cooling time credit.
Integral absorber credit	YES	Section 5.3 of Attachment 7
Other credit	NO	No other credit.

Subject	Included	Notes / Explanation
Fixed neutron absorbers	YES	Credit for NETCO SNAP-IN® Neutron Absorbing inserts.
Aging management program	YES	Section 3.9 of Enclosure 1
Accident analysis	YES	Section 5.5.3 of Attachment 7
Temperature increase	YES	Section 5.5.3/Section 5.4.1 of Attachment 7
Assembly drop	YES	Section 5.5.3 of Attachment 7
Single assembly misload	NO	Uniform pool with peak reactivity fuel, so no opportunity for misload.
Multiple misload	NO	
Boron dilution	NO	Not applicable - No soluble boron is used at RBS.
Other	YES	Section 5.5.3 of Attachment 7
Fuel out of rack analysis	YES	5.5.2 of Attachment 7
Handling		
Movement		
Inspection		
6.0 Computer Codes, Cross Sections and Validation Overview		
Code/Modules Used for Calculation of k_{eff}	YES	Described in Section 3.0 of Attachment 7.
Cross section library	YES	Section 3.1 of Attachment 7
Description of nuclides used	YES	Section 4.3 of Attachment 7
Convergence checks	YES	Section 3.3 of Attachment 7
Code/Module Used for Depletion Calculation	YES	Described in Section 3.0 of Attachment 7.
Cross section library	YES	Section 3.1 of Attachment 7
Description of nuclides used	YES	Section 4.3 of Attachment 7
Convergence checks	YES	Section 3.3 of Attachment 7
Validation of Code and Library	YES	Section 3.4/Appendix A of Attachment 7
Major Actinides and Structural Materials	YES	Section 3.4 of Attachment 7
Minor Actinides and Fission Products	YES	Section 3.4 of Attachment 7
Absorbers Credited	YES	Section 3.4 of Attachment 7
7.0 Criticality Safety Analysis of the New Fuel Rack		
Rack model	NO	See Section 2.3 of Enclosure 1. The proposed change does not include the new fuel storage racks.
Boundary conditions		
Source distribution		
Geometry restrictions		

Subject	Included	Notes / Explanation
Limiting fuel design		
Fuel density		
Burnable Poisons		
Fuel dimensions		
Axial blankets		
Limiting rack model		
Storage vault dimensions and materials		
Temperature		
Multiple regions/configurations		
Flooded		
Low density moderator		
Eccentric fuel placement		
Tolerances		
Fuel geometry		
Fuel pin pitch		
Fuel pellet OD		
Fuel clad OD		
Fuel content		
Enrichment		
Density		
Integral absorber		
Rack geometry		
Rack pitch		
Cell wall thickness		
Storage vault dimensions/materials		
Code uncertainty		
Biases		
Temperature		
Code bias		
Moderator Conditions		
Fully flooded and optimum density moderator		
8.0 Depletion Analysis for Spent Fuel		
Depletion Model Considerations	YES	Described in Section 3.3, Section 3.7, and 4.3 of Attachment 7.
Time step verification		
Convergence verification		
Simplifications		
Non-uniform enrichments		
Post Depletion Nuclide Adjustment		
Cooling Time		
Depletion Parameters		
Burnable Absorbers		
Integral Absorbers		
Soluble Boron		

Subject	Included	Notes / Explanation
Fuel and Moderator Temperature		
Power		
Control rod insertion		
Atypical Cycle Operating History		
9.0 Criticality Safety Analysis of Spent Fuel Pool Storage Racks		
Rack model	YES	Section 5.2 of Attachment 7
Boundary conditions		
Source distribution		
Geometry restrictions		
Design Basis Fuel Description	YES	Section 5.3 of Attachment 7
Fuel density	YES	Section 4.1 of Attachment 7
Burnable Poisons	YES	Section 5.3 of Attachment 7
Fuel assembly inserts	NO	No fuel assembly inserts in this analysis.
Fuel dimensions	YES	Section 4.1 and 4.2 of Attachment 7
Axial blankets	NO	Section 3.7 of Attachment 7.
Configurations considered	YES	Single configuration, uniform pool, see Section 6.0 of Attachment 7.
Borated	NO	Not applicable for this analysis.
Unborated	YES	
Multiple rack designs	NO	N/A. One rack design with inserts in every location.
Alternate storage geometry	NO	Not applicable for this analysis.
Reactivity Control Devices	YES	
Fuel Assembly Inserts	NO	No fuel assembly inserts in this analysis.
Storage Cell Inserts	YES	NETCO SNAP-IN® inserts – Section 5.1 of Attachment 7.
Storage Cell Blocking Devices	NO	No cells are required to be empty so no blocking devices are considered in this analysis.
Axial burnup shapes	NO	See Section 3.7 of Attachment 7.
Uniform/Distributed	YES	
Nodalization	NO	
Blankets modeled	NO	
Tolerances/Uncertainties	YES	Section 5.6 of Attachment 7
Fuel geometry		
Fuel rod pin pitch		
Fuel pellet OD		

Subject	Included	Notes / Explanation
Cladding OD		
Axial fuel position	NO	See Section 3.7 of Attachment 7.
Fuel content	YES	Section 5.6 of Attachment 7
Enrichment		
Density		
Assembly insert dimensions and materials	NO	No fuel assembly inserts in this analysis.
Rack geometry	YES	Section 5.6 of Attachment 7
Flux-trap size (width)	NO	N/A. RBS has an egg crate rack design.
Rack cell pitch	YES	Section 5.6 of Attachment 7
Rack wall thickness	NO	No tolerance specified by manufacturer. See Section 5.6.1 of Attachment 7.
Neutron Absorber Dimensions	NO	N/A, since Boraflex is modeled as water. See Section 5.6.1 of Attachment 7.
Rack insert dimensions and materials	YES	Section 5.6 of Attachment 7
Code validation uncertainty	YES	Described in Section 3.4/Section 5.7 of Attachment 7.
Criticality case uncertainty	YES	Section 5.7 of Attachment 7
Depletion Uncertainty	YES	Described in Section 3.4 and Section 5.7 of Attachment 7.
Burnup Uncertainty	NO	Not applicable for BWR peak reactivity analysis.
Biases	YES	Section 5.0 of Attachment 7
Design Basis Fuel design	YES	Section 5.3 of Attachment 7
Code bias	YES	Section 3.4/Section 5.5.4 of Attachment 7
Temperature	YES	Section 5.4/Section 5.5.4 of Attachment 7
Eccentric fuel placement	YES	Not applicable, see Section 5.4.1 of Attachment 7.
Incore thimble depletion effect	NO	Not applicable for this analysis.
NRC administrative margin	YES	Described as administrative margin in Section 5.8 of Attachment 7.
Modeling simplifications	YES	Section 3.7 and 4.3 of Attachment 7
Identified and described		
10.0 Interface Analysis		
Interface configurations analyzed	NO	N/A, since the pool is uniform with rack inserts in every cell.
Between dissimilar racks	NO	

Subject	Included	Notes / Explanation
Between storage configurations within a rack	NO	See Section 6.0 of Attachment 7.
Interface restrictions	NO	None
11.0 Normal Conditions		
Fuel handling equipment	YES	Section 5.5.2 of Attachment 7
Administrative controls	YES	Defective fuel storage locations are procedurally not allowed to have fuel stored in them (Section 3.1.2 of Enclosure 1). Assemblies with missing pins are not to be stored in the SFP storage racks (Section 4 of Attachment 7).
Fuel inspection equipment or processes	YES	Section 5.5.2 of Attachment 7
Fuel reconstitution	YES	Replaced rods are covered, but storage of assemblies with missing pins is not allowed. See Section 4.0 of Attachment 7.
12.0 Accident Analysis		
Boron dilution	NO	Not applicable - No soluble boron used at RBS.
Normal conditions		
Accident conditions		
Single assembly misload	NO	Uniform pool with peak reactivity fuel, so no opportunity for misload.
Fuel assembly misplacement	YES	Section 5.5.3 of Attachment 7
Neutron Absorber Insert Misload	YES	Section 5.5.2 of Attachment 7
Multiple fuel misload	NO	Uniform pool with peak reactivity fuel, so no opportunity for misload.
Dropped assembly	YES	Section 5.5.3 of Attachment 7
Temperature	YES	Section 5.5.3 of Attachment 7
Seismic event/other natural phenomena	YES	Section 5.5.3 of Attachment 7
13.0 Analysis Results and Conclusions		
Summary of results	YES	Section 5.8/7.0 of Attachment 7
Burnup curve(s)	NO	Not applicable for BWR peak reactivity analyses.
Intermediate Decay time treatment	NO	Not applicable for BWR peak reactivity analyses. See Section 4.3 of Attachment 7.

Subject	Included	Notes / Explanation
New administrative controls	YES	Defective fuel storage locations are procedurally not allowed to have fuel stored in them (Section 3.1.2 of Enclosure 1). Assemblies with missing pins are not to be stored in the SFP storage racks (Section 4 of Attachment 7).
Technical Specification markups	YES	See Attachment 1
14.0 References	YES	**Section 8.0 of Attachment 7**
Appendix A: Computer Code Validation:		**Appendix A of Attachment 7**
Code validation methodology and bases	YES	Appendix A of Attachment 7
New Fuel		
Depleted Fuel		
MOX		
HTC		
Convergence		
Trends		
Bias and uncertainty		
Range of applicability	YES	Described in Section 3.4 of Attachment 7.
Analysis of Area of Applicability coverage	YES	Described in Section 3.4 of Attachment 7.

ATTACHMENT 5
RBG-47900

GLOBAL NUCLEAR FUEL – AMERICAS
10 CFR 2.390 AFFIDAVIT

Global Nuclear Fuel – Americas

AFFIDAVIT

I, **Lisa K. Schichlein,** state as follows:

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

(2) The information sought to be withheld is contained in GNF-A proprietary report, NEDC-33886P, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018. GNF-A proprietary information within the text and tables is identified by a dotted underline placed within double square brackets. [[This sentence is an example.{3}]] Figures and large objects containing GNF-A proprietary information are identified with double square brackets before and after the object. In all cases, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GNF-A 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 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also 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, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).

(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 GNF-A's competitors without license from GNF-A 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 aspects of past, present, or future GNF-A customer-funded development plans and programs, resulting in potential products to GNF-A;

d. 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. and (4)b. above.

(5) To address 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GNF-A, 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 GNF-A, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to 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, or subject to the terms under which it was licensed to GNF-A.

(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 delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GNF-A 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 identified in paragraph (2), above, is classified as proprietary because it contains details of GNF-A's fuel design and licensing methodology. The development of this methodology, along with the testing, development and approval was achieved at a significant cost to GNF-A or its licensor.

The development of the fuel design and licensing methodology along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GNF-A asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GNF-A's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GNF-A's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical, and NRC review costs comprise a substantial investment of time and money by GNF-A.

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.

GNF-A's competitive advantage will be lost if its competitors are able to use the results of the GNF-A 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 GNF-A 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 GNF-A of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 17th day of October 2018.

Lisa K. Schichlein

Lisa K. Schichlein
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ATTACHMENT 6
RBG-47900

CURTISS-WRIGHT
10 CFR 2.390 AFFIDAVIT

CURTISS-WRIGHT AFFIDAVIT PURSUANT TO 10 CFR 2.390

I, Karl Scot Leuenroth, depose and say that I am the Division Manager of Curtiss-Wright's Scientech Division, duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below.

I am submitting this affidavit in conformance with the provisions of 10 CFR 2.390 of the Commission's regulations for withholding Curtiss-Wright's information for which proprietary treatment is sought as contained in NEDC-33885P, "River Bend Station: Fuel Storage Criticality Safety Analysis of Spent Fuel Storage Racks with Rack Inserts," Revision 1, October 2018.

I have personal knowledge of the criteria and procedures utilized by Curtiss-Wright in designating information as a trade secret, privileged or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1) The information sought to be withheld from public disclosure is a list technical information related to the Snap-In Insert technology, which involve considerable research and development of intellectual property by Curtiss-Wright. Curtiss-Wright Flow Control and Services Corporation (CW) information is identified by a solid underline inside double square brackets. [[This sentence is an example.{C}]] CW proprietary information in figures and large objects is identified by double square brackets before and after the object.

2) The information is of a type customarily held in confidence by Curtiss-Wright, and not customarily disclosed to the public. Curtiss-Wright has a rational basis for determining the types of information customarily held in confidence by it.

3) The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.390 with the understanding that it is to be received in confidence by the Commission.

4) The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

5) Public disclosure of the information is likely to cause substantial harm to the competitive position of Curtiss-Wright because:

a) A similar product is manufactured and sold by competitors of Curtiss-Wright.

b) Development of this information by Curtiss-Wright required expenditure of considerable resources. To the best of my knowledge and belief, a competitor would have to undergo similar expense in generating equivalent information.

c) In order to acquire such information, a competitor would also require considerable time and inconvenience related to the development of a design and analysis of a similar neutron attenuation technology for use in a spent fuel pool.

d) The availability of such information to competitors would enable them to modify their product to better compete with Curtiss-Wright, take marketing or other actions to improve their product's position or impair the position of Curtiss-Wright's product, and avoid developing similar data and analyses in support of their processes, methods or apparatus.

[signature]

Karl Scot Leuenroth

State of Connecticut)

) SS: Bethel

County of Fairfield)

On this 16th day of October, 2018, before me, the undersigned Notary Public, personally appeared Mr. Karl Scot Leuenroth, known to me (or satisfactorily proven) to be the person whose name is subscribed to the Affidavit, and acknowledged that he executed same for the purposes therein contained.

In witness whereof, I hereunto set my hand and official seal.

Josh R DiBella

Notary Public

JOSH R. DiBELLA
NOTARY PUBLIC
My Commission Expires 03/31/2023