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10 CFR 50.90
L-2009-249
October 31, 2009

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington D.C. 20555-0001

Re: Turkey Point Unit 4
Docket No. 50-251
Issuance of Amendment Regarding Spent Fuel Boraflex Remedy
Supplement 3 to Request for a Change in Implementation Date

References:

1. Letter from Michael Kiley (FPL) to USNRC, "Implementation Date Change for License Amendments 234 and 229," L-2009-200, September 1, 2009.

2. Letter from Michael Kiley (FPL) to USNRC, "Issuance of Amendment Regarding Spent Fuel Boraflex Remedy – Supplement 2 to Request for a Change in Implementation Date," L-2009-247, October 29, 2009.

3. Letter from B. L. Mozafari (USNRC) to J. A. Stall (FPL), "Turkey Point Plant Units 3 and 4 - Issuance of Amendments Regarding Spent Fuel Boraflex Remedy (TAC No. MC9740 and MC9741)," July 17, 2007.

4. Westinghouse Nuclear Safety Advisory Letter NSAL-00-015, Axial Burnup Shape Reactivity Bias, November 2, 2000.

5. Letter from Stephen Dembek (USNRC) to H. A. Sepp (Westinghouse), Non-Conservatives in Axial Burnup Biases for Spent Fuel Rack Criticality Analysis Methodology, July 27, 2001.

Florida Power and Light Company (FPL) submitted an application for amendment of the Unit 3 and 4 licenses in Reference 1. The application was supplemented by FPL for Unit 4 in Reference 2. This letter provides additional information regarding Unit 4 and corrects an error in Reference 2.

In Reference 2, the last sentence of the third paragraph on page 2 states: "The projected maximum Boraflex degradation by the requested implementation date for Amendment 229 of September 30, 2012 remains well above the maximum degradation of Boraflex assumed in the analysis supporting Reference 3." This sentence is hereby corrected to state:

> "The projected maximum Boraflex degradation by the requested implementation date for Amendment 229 of September 30, 2012 remains well **below** the maximum degradation of Boraflex assumed in the analysis supporting Reference 3."

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Turkey Point Unit 4 License Amendment No. 229 was issued by the NRC in Reference 3. As stated in Reference 3 the implementation date of the license amendment is stated thusly: "This license amendment is effective as of its date of issuance and shall be implemented prior to the end of Turkey Point Unit 4 Cycle 24." In order to clarify the approximate time of the end of Turkey Point Unit 4 Cycle 24, FPL has defined this to be: At the commencement of Mode 6 for the core reload for Turkey Point Unit 4 Cycle 25. Currently, the commencement of Mode 6 for Unit 4 reload for Cycle 25 is projected to be 0200 hours on November 13, 2009. This time remains approximate as it is dependent on other outage activities.

In a conference call with the NRC staff on October 30, 2009, FPL discussed the assessment of the impact of an error in the methodology employed for Turkey Point's current criticality analysis that was identified in Westinghouse Nuclear Safety Advisory Letter NSAL-00-015 (Reference 4, attached) regarding a non-conservative application of an axial burnup shape bias. The NSAL identified analysis conservatisms that could be used to offset the penalty from the error. As recommended in NSAL-00-015, a Turkey Point specific assessment of the impact was performed that concluded crediting some of the conservatisms in the Turkey Point analysis was sufficient to offset the effect of the penalty from the non-conservative application of the axial burnup shape bias. It was not necessary to credit the margin between the Turkey Point design basis analysis calculated 95/95 k_{eff} and the k_{eff} limit to reach this conclusion. Additionally regarding this issue, the USNRC staff concluded in Reference 5, "Because of the large conservatisms used in other aspects of the methodology, the staff does not view the nonconservatisms in the calculated biases as a safety concern."

FPL has determined that the additional information provided above does not impact the conclusions of the No Significant Hazards Consideration determination in Reference 1.

If you have any questions or require additional information, please contact Robert Tomonto at 305-246-7327.

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

Very truly yours,

10/31/2009

Executed on

Michael Kiley
Vice President – Turkey Point Nuclear Plant

Attachment: Westinghouse Nuclear Safety Advisory Letter NSAL-00-015

cc: Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Nuclear Plant
USNRC Project Manager for Turkey Point
Mr. William Passetti, Florida Department of Health

Attachment

Florida Power and Light Letter L-2009-249

Issuance of Amendment Regarding Spent Fuel Boraflex Remedy
Supplement 3 to Request for a Change in Implementation Date

Westinghouse Nuclear Safety Advisory Letter NSAL-00-0015

Axial Burnup Shape Reactivity Bias
8 Pages

Nuclear Safety Advisory Letter

Westinghouse Electric Company

This is a notification of a recently identified potential safety issue pertaining to basic components supplied by Westinghouse. This information is being provided to you so that a review of this issue can be conducted by you to determine if any action is required.

P.O. Box 355, Pittsburgh, PA 15230

Subject: AXIAL BURNUP SHAPE REACTIVITY BIAS	**Number:** NSAL-00-015
Basic Component: Spent Fuel Criticality Analysis	**Date:** November 2, 2000

Plants: Beaver Valley 2, Comanche Peak 1 & 2, Turkey Point 3 & 4, Maanshan 1 & 2, Indian Point 3, Millstone 3, V. C. Summer, Braidwood 1 & 2, Farley 1 & 2, Prairie Island 1 & 2, South Texas 1 & 2, Vogtle 1 & 2, Krsko, North Anna 1 & 2

Substantial Safety Hazard or Failure to Comply Pursuant to 10 CFR 21.21(a)	Yes ☐	No ☒
Transfer of Information Pursuant to 10 CFR 21.21(b)	Yes ☐	
Advisory Information Pursuant to 10 CFR 21.21(d)(2)	Yes ☐	

References: WCAP-14416-NP-A, Revision 1, "Westinghouse Spent Fuel Rack Criticality Analysis Methodology," Newmyer, W D., November 1996.

SUMMARY

The Westinghouse methodology for determining spent fuel criticality allows a criticality credit by considering the reactivity decrease associated with fuel depletion (called burnup credit reactivity equivalencing). The methodology relies on two-dimensional (2D) radial calculations using PHOENIX-P. To account for axial, or three-dimensional (3D), burnup effects, a reactivity "bias" was identified on a generic basis in the referenced WCAP. This methodology has been used to establish plant technical specification limits.

Recent calculations, using the Westinghouse methodology, have shown that the calculated axial burnup bias could be non-conservative. Close examination of the methodology also revealed several areas where additional credits could be technically justified. In some cases, these credits were not assumed as part of the methodology topical but are acknowledged, relevant factors as to the potential condition of the spent fuel pool.

Information is provided within this advisory letter for plant-specific evaluations necessary to conform to the guidance of US NRC Generic Letter 91-18 Revision 1, if required. The reactivity bias penalty due to the non-conservatism was calculated along with the quantification of the technically justifiable credits on a generic basis. For potentially affected plants, the results show the net effect to be no more limiting than results calculated using the WCAP methodology. That is, the current technical specification limits on spent fuel pool loading configurations for potentially affected plants are technically acceptable and the curves in the technical specification remain valid. On this basis, Westinghouse has identified no compensatory actions on the part of the potentially affected plants. Plants that use the WCAP-14416-NP-A burnup credit methodology, in whole or part, should review their analysis method to determine if the non-conservative axial-bias applies to them.

Additional information, if required, may be obtained from the originator. Telephone 412-374-4856.

Originator(s):

D. A. Lindgren	W. H. Slagle	H. A. Sepp
Regulatory and Licensing Engineering	Core Analysis B	Regulatory and Licensing Engineering

ISSUE DESCRIPTION

The Westinghouse methodology for spent fuel criticality is described in Reference 1, and has been approved by the NRC. The methodology includes a technique where credit can be taken in criticality analyses by considering the reactivity decrease associated with fuel depletion (called burnup credit reactivity equivalencing).

The calculations for burnup credit reactivity equivalencing are done on a radial, two-dimensional (2D) basis with the PHOENIX-P code. Inherent in a 2D treatment for this calculation is a uniform axial burnup distribution. To account for the varying burnup and reactivity axially along the assembly, that is, the three-dimensional (3D) burnup effect, a bias term had been defined in Reference 1 using the PHOENIX-P and ANC codes.

An issue was identified in a calculation of burnup credit for the spent fuel rack criticality analysis by a utility owner for its plant of Westinghouse design. Using a different methodology and set of assumptions, and alternate calculation codes, the calculation suggested a larger axial bias term with a lower burnup application limit (burnup at which the "bias" results in more severe reactivity results) than that calculated by Westinghouse. The NRC was notified of these preliminary results in March 2000, by the utility, prompting an investigation by Westinghouse with respect to the reported sensitivity.

The listed plants are those for which Westinghouse Electric has performed the spent fuel pool criticality analysis or those plants for which Westinghouse knows that the WCAP-14416-NP-A methodology is used to determine axial bias. Since WCAP-14416-NP-A was developed as part of a Westinghouse Owners Group project, it was available for use by any participating utility.

LICENSING BASIS

There are two general design criteria (10 CFR Part 50 Appendix A) that are relevant to the analysis of spent fuel pool criticality.

- General Design Criterion 61 (Fuel Storage and Handling and Radioactivity Control) provides that the fuel storage and handling, radioactive waste, and other systems which may contain radioactivity, shall be designed to assure adequate safety under normal and postulated accident conditions.

- General Design Criterion 62 (Prevention of Criticality in Fuel Storage and Handling) provides that criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.

TECHNICAL EVALUATION

An investigation was conducted which focused on various aspects of the spent fuel pool criticality analysis. Both the methods and assumptions used in the analysis were reviewed. The first part of the investigation centered on a detailed review of the methods and assumptions used in the Westinghouse analyses and those used by others in the nuclear industry. As a result of this part of the investigation, the axial bias non-conservatism was verified and several conservatisms were identified and documented. This part of the investigation was conducted by Westinghouse personnel and other nuclear industry individuals.

The magnitude of non-conservatism varies from plant to plant. It also varies among configurations. The typical range of values of the non-conservatism is 0 to 0.03000 delta-K based on the configuration and burnup. For some checkerboard type loading patterns the effect of the non-conservatism on criticality calculations may be as low as zero. The maximum value for non-conservatism in the axial bias is typically for configurations of the highest required burnup.

The second part of the investigation was a generic evaluation of previous analyses performed by Westinghouse, for various plants, which accounted for the findings of the detailed review conducted in the first part of the investigation. From these evaluations, certain conservatisms in the methodology also were confirmed which would tend to offset the non-conservative nature of the bias, if they were to be factored into the previous plant-specific analysis. The conclusion of the evaluations was that the credit for the overall conservatisms identified in the survey of plant analyses is sufficient to offset the effects of the revised axial burnup bias identified above. It should be noted that for some plants, which credit soluble boron in defining the burnup credit, the actual amount of boron needed to meet the $k_{eff} < 0.95$ requirement is known and was properly allocated. However, additional available boron was not credited in the evaluations presented herein nor was soluble boron credit assumed for plants that are not licensed for soluble boron credit.

EVALUATION OF CONSERVATIVE CREDITS

The evaluations were conducted for plants for which the Westinghouse methodology for determining spent fuel criticality had been applied. Generic conservatisms, applicable to these plant analyses, were determined which showed that the plant analyses would be acceptable on a net basis. That is, the potential non-conservatism of the axial burnup bias would be less than the demonstrated generic conservatisms identified. It should be noted that in evaluating the previous plant-specific analyses, not all of the generic conservatisms have been used and not to the same degree. The conservatisms and the calculation of the credits are described below. The values stated for the credits are typical values and are subject to plant specific variation. These generic values may not add up to the 0.03000 delta-K that was previously identified as the upper range of the non-conservatism.

- <u>Discrete Lattice Single Rack Cell Assumption</u>

  Westinghouse has typically represented each spent fuel pool with an infinitely repeating single cell assumption. This assumption, by definition, produces zero leakage in the horizontal direction of the spent fuel pool. Also, because of this single cell assumption, Westinghouse has modeled all of the inventory in the spent fuel pool with a single assembly description. The purpose of the evaluation is to quantify the reactivity associated with the leakage out of modules (which is a collection of fuel assemblies separated by varying amounts of water) and the reactivity effect associated with a more realistic, and yet conservative, description of the inventory in the spent fuel pool. The analysis directly simulated the reactivity effects of leakage out of a module and the "global" mixing of different assembly burnups within a typical spent fuel pool. The leakage out of a typically sized module (10x10 arrangement of fuel assemblies) was calculated for two different intra-module (between module) gap sizes: 2.0 cm (0.79 inch) and 5.08 cm (2 inches). The calculated leakage for the 2 cm gap between modules is 0.00777 delta-K. The calculated leakage for the 5.08 cm gap between modules is 0.01081 delta-K.

  The assumption that all fuel assemblies are discharged into the spent fuel pool with a single limiting axial burnup profile is very conservative. In reality, the fuel assemblies are discharged into the spent fuel pool with axial burnup profiles that would produce lower reactivity results. However, it is reasonable to assume that the magnitude of this effect is approximately equal to the reactivity associated with the mixing of modules loaded with varying assembly burnups. The reactivity effect associated with the mixing of different assembly burnups within a spent fuel pool was approximated. This was accomplished by checker-boarding modules with different assembly burnups. The minimum calculated reactivity worth of this effect is 0.00147 delta-K and the maximum calculated reactivity worth is 0.00292 delta-K. The average of these two values, 0.00220 delta-K, would reasonably represent the spectrum of assembly burnups expected within a typical spent fuel pool. It is expected that a checkerboard of differing burnup assemblies within a rack module would give at least twice the benefit. Therefore, the total reactivity effect of varying the axial burnup shapes within a module and varying the spectrum of assembly burnups within the spent fuel pool is calculated to be 0.00440 delta-K.

The total combination of the expected leakage out of the single cell assumption along with the mixing of axial burnup profiles and assembly burnups within the spent fuel pool is 0.01217 delta-K (e.g., 0.00777 delta-K + 0.00440 delta-K). Thus, it has been conservatively reduced to 0.01100 delta-K.

- <u>Presence Of Samarium And Fission Product Buildup</u>

In the current methodology, no credit for samarium and fission products is assumed. The typical minimum cooling time is 100 hours after shutdown before the fuel movement can be performed. One hundred (100) hours will cover most plants for a generic analysis. The one plant that is an exception (42 hours cooling) does not take samarium credit.

Typical fuel enrichments for reload cores range from 3 to 5 w/o. So the data for the 3 and 5 w/o values are used. This is deemed conservative because the data trends seem to credit samarium less with increased enrichment. The credits for a range of burnups are used to develop the average value. Assemblies with only 30,000 MWD/MTU burnup or lower are typically not of concern for axial burnup bias. The bias for 30,000MWD/MTU assemblies is not substantial.

For assemblies that are not at full power, for example periphery assemblies, a penalty must be applied in final accounting. A part-power factor of 0.7 is taken and used. The typical samarium credit for the buildup of samarium and fission products after shutdown results in a negative reactivity credit of approximately 0.00200 delta-K.

- <u>Decay Time Credit</u>

Spent fuel decay time credit results from the radioactive decay of isotopes in the spent fuel to daughter isotopes. This decay results in reduced reactivity. Credit is taken only for the decay of actinides, mainly the decay of Pu-241 (fissile isotope) to Am-241 (poison absorber). Westinghouse has evaluated up to 5 years of decay time credit in evaluation of previous analyses for all cell configurations since this configuration has a large axial burnup bias. No decay time credit was necessary for checkerboard type configurations since this configuration has negligible axial burnup bias.

- Pool Leakage

  In the current methodology, the storage cells are assumed to be infinite in the lateral (x and y) direction. In the actual storage pool, leakage occurs between the rack module and into the pool wall. The gap between the racks and the sides of the pool was set at 2 inches and larger. A concrete boundary of 24 inches was used. The results for the various gap sizes at the wall are virtually identical. The model also considers no absorber panels on external faces of periphery cells. Based on the evaluations of previous analyses, it has been determined that 0.00035 delta-K credit can be taken on a generic basis when accounting for the leakage between storage rack modules and the pool wall. If additional credit is needed, a plant specific engineering evaluation can be made to raise the credit to as high as 0.00100 delta-K.

- Boron LetdoWn Curve For Hot Full PoWer Depletion

  In the current methodology, the fuel assembly depletion is performed with a constantly high value of soluble boron (e.g., a value of 1500-1700 ppm is used for burnup from 0 to 60,000 MWD/MTU). In actual operation, the soluble boron decreases during the cycle (e.g., typically a high boron value at the beginning-of-cycle, and a near zero value at the end-of-cycle). The lower cycle average boron value, for actual operations, results in a softer neutron spectrum, and makes the fuel assemblies less reactive with burnup due to the smaller buildup of plutonium. For the generic evaluation of previous analyses described earlier, a bounding boron letdown curve was assumed (e.g., 1500 ppm boron at beginning-of-cycle to 0 ppm at end-of-cycle) that also included burnable absorbers; therefore, the assemblies in the core will be less reactive.

- Existing Delta To The K_{eff} Limit

  This is the difference between the k_{eff} limit of 0.95 (for no soluble boron credit) or 1.00 (for soluble boron credit) and the calculated value of k_{eff} determined on a 95/95 basis.

- Grid And Sleeve Credit

  Under the current methodology, no credit is taken for the presence of grids and sleeves. This credit is determined to be in the range of 0.00300 delta-K to 0.00900 delta-K, depending on fuel type. A portion of this credit is reserved for another issue, leaving 0.00090 to 0.00690 delta-K.

The following three credits are grouped since the tolerance uncertainties for enrichment, density, dishing and others, are handled in the current methodology through statistical convolution. Therefore, it is not practical to separate out individual impacts and determine a credit. This is specifically true since the magnitude of the following three credits are plant-specific and a generic value can not be provided as representative for all plants.

- Enrichment Tolerance

  In the current methodology, the standard DOE tolerance is ± 0.05 w/o U235 about the allowable enrichment for fresh fuel with no burnup. The allowable initial enrichment in the base methodology is usually low (less than 2.0 w/o) for storage in all cells. This results in a rather large uncertainty from a reactivity standpoint. Note: the assembly enrichment in reload cores is usually in the range of

3.0 to 5.0 w/o. The enrichment tolerance uncertainty for high burnup fuel at a higher enrichment of up to 5.0 w/o U235 is significantly smaller.

- Density Tolerance

  In the current methodology, a ± 2.0% variation about the nominal UO_2 theoretical density of 95 to 96% is used. The specification for the maximum theoretical density at the Westinghouse fuel manufacturing site is 96.5% on a fuel assembly average basis. Therefore, the density tolerance on the positive side should be only +0.5 to +1.5%. This results in a lower density reactivity tolerance uncertainty compared to the current methodology.

- Dishing Tolerance

  In the current methodology, a 0% pellet effective dishing is assumed for the dishing tolerance uncertainty. This results in a measureable dishing reactivity tolerance value. Pellets are actually manufactured with a chamfer and dishing. Therefore, a conservative approach is to take credit only for 50% of the nominal dishing. This results in a significant reduction in the dishing reactivity tolerance value.

SUMMARY

To reiterate, the conclusions drawn from the evaluation are that the credits for the overall conservatisms identified in the survey of plants are sufficient to offset the effect of the revised axial burnup bias. Analyses based on the referenced WCAP that have not yet been completed or that were not performed by Westinghouse may employ a similar approach to demonstrate the conservatism of the results. Alternately, the axial burnup bias may be specifically addressed in the analysis to ensure that a conservative approach is used.

EFFECT ON DESIGN BASIS AND DESIGN REQUIREMENTS

Adequate safety under normal and postulated accident conditions for fuel storage and handling (GDC 61) is provided by the structural integrity operational performance of the spent fuel pool, spent fuel racks, and the spent fuel pool cooling system. The method of analyzing spent fuel pool criticality does not affect structural integrity or operational performance. Preventing criticality in the fuel storage and handling system (GDC 62) is provided by maintaining k_{eff} less than or equal to 0.95, at a 95% probability, 95% confidence level when accounting for the presence of boron or k_{eff} less than or equal to 1.00, at a 95% probability, 95% confidence level when not accounting for any boron presence. The evaluation of the net effect of the non-conservative axial burnup bias and the available credit for conservatisms in the WCAP-14416-NP-A methodology demonstrates that this requirement continues to be satisfied.

The interface between the fuel assembly and the fuel handling equipment and storage racks is not altered. The design requirements for the fuel storage racks are not altered. The spent fuel handling tools do not have to be altered. The fuel handling procedures are not affected.

The fuel assemblies, fuel rods, evaluation of criticality in the reactor vessel during refueling, and performance of the reactor coolant and supporting systems are not affected by the non-conservatism in the spent fuel criticality methodology.

PLANT TECHNICAL SPECIFICATIONS

The plant Technical Specifications typically includes limits on spent fuel pool rack loading configurations. These limits provide a margin of safety with respect to criticality in the spent fuel storage racks. The limits account for fuel assembly enrichment and burnup. The technical specification limits for the affected plants are based on the WCAP-14416-NP-A methodology. Removing some of the conservatisms from the analysis with the revised axial bias and accounting for the additional identified conservatisms shows that the technical specification limits remain valid. Fuel assemblies do not have to be moved. The limit on reactivity in the spent fuel pool is not reduced.

The use of the conservatisms in the calculation of the limits on placement of the spent fuel represents a change to the evaluation that supports the normal plant configuration. The FSAR discussion of criticality in the spent fuel pool and the description of the basis of the technical specification should be reviewed for impact.

ASSESSMENT OF SAFETY SIGNIFICANCE

Evaluations factoring in the axial bias correction and using identified conservatisms in the analysis, and acknowledgment of actual conditions demonstrate that k_{eff} remains less than or equal to the limit for potentially affected plants. Therefore, the current spent fuel pool configurations for the potentially affected plants are technically acceptable and continue to provide a geometrically safe configuration.

NRC AWARENESS/REPORTABILITY CONSIDERATIONS

The utility that identified this issue informed the NRC via a Licensee Event Report (Event Number 36748, 03/02/2000). Westinghouse has discussed this issue with the NRC staff with regards to the investigation, subsequent results, and notification plans.

The evaluation of the credits for conservatism and the review of the technical specification basis outlined above demonstrate that k_{eff} remains less than 0.95. There is no loss of safety function such that there is a reduction in the degree of protection provided to public health and safety. Therefore, this issue does not constitute a Substantial Safety Hazard as defined in 10 CFR Part 21 and is not reportable as a Part 21 item.

RECOMMENDED ACTIONS

The current spent fuel pool technical specification loading configurations for the potentially affected plants are technically acceptable based on the evaluations described herein. Regulatory and licensing commitments may require additional licensing activities. These may include a review of operation using the guidance of Generic Letter 91-18, Revision 1, preparation of a 10 CFR 50.59 evaluation, or updating the basis of the technical specifications. The key assumptions used in the Westinghouse evaluations have been delineated herein.

Plants that use the WCAP-14416-NP-A burnup credit methodology in whole or part should review their analysis method to determine if the non-conservative axial-bias applies to them. On a plant-specific basis, the non-conservative axial bias calculations should be reviewed to determine if this condition represents a nonconforming or degraded condition as defined in US NRC Generic Letter 91-18, Revision 1. The documentation and evaluation requirements needed to address the guidance of Generic Letter 91-18, Revision 1 is determined on a plant specific basis. WCAP-14416-NP-A may be considered part of the plant design or licensing basis. The actions required to confirm the technical specification limits on spent fuel loading configurations is also a plant-specific effort.

Evaluations performed to address the guidance of Generic Letter 91-18, Revision 1 may include an assessment of continued operation. The items that are considered appropriate in the consideration of continued operation include conservatisms and margins. The conservatisms available in the criticality analysis are outlined above. The result that the credit for the conservatisms is sufficient to offset the effect of the revised axial bias may be used as the basis for continued operation.

The evaluations that supported preparation of this advisory letter have determined that compensatory actions are not required. The fuel currently stored in the spent fuel pool does not have to be moved. The fuel assemblies of approved designs in the current or future cores may be stored in the spent fuel rack using existing limits.

Note: The affected plants received a plant-specific margin summary (rack up) as an attachment with the transmittal of this NSAL.