Progress Energy

Crystal River Nuclear Plant
Docket No. 50-302
Operating License No. DPR-72

Ref: 10 CFR 50.90

July 19, 2007
3F0707-05

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

Subject: Crystal River Unit 3 – License Amendment Request #292, Revision 1: Additional Storage Patterns for Crystal River Unit 3 Storage Pools A and B and Response to Request for Additional Information (TAC No. MD3308)

References:
1. Crystal River Unit 3 to NRC Letter dated October 5, 2006, "Crystal River Unit 3 – License Amendment Request #292, Revision 0: Additional Storage Patterns for Crystal River Unit 3 Storage Pools A and B"
2. NRC to Crystal River Unit 3 Letter dated June 20, 2007, "Crystal River, Unit No. 3, Request for Additional Information Regarding Additional Storage Patterns for Spent Fuel Pools (TAC No. MD3308)"

Dear Sir:

On June 20, 2007, the Nuclear Regulatory Commission (NRC) issued a Request for Additional Information (RAI, Reference 2) regarding License Amendment Request (LAR) #292 (Reference 1). In accordance with the provisions of 10 CFR 50.90, Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., hereby provides Revision 1 to License Amendment Request #292 and the response to the RAI.

Revision 0 of this LAR submitted changes to the Crystal River Unit 3 (CR-3) Improved Technical Specifications (ITS) to:

- Revise the defined pool burnup-enrichment requirements,
- Revise the storage configuration for fresh fuel and low burnup/high enriched fuel,
- Revise the definition of a peripheral assembly, and
- Make other minor editorial changes.

This submittal requests changes to the CR-3 ITS to make some clarifications to the definition of a peripheral assembly, to Figures 3.7.15-1 and -2, and to the Bases.

This submittal contains six attachments. The content of the attachments is as follows:

A001
NRR

- Attachment A contains the FPC response to the RAI questions in Reference 2.
- Attachment B contains a revised Description of the Proposed Change and Justification for the Request. It was necessary to make minor changes to the content from Attachment A in Reference 1 to reflect the RAI responses such as the new definition for peripheral assembly. Attachment B to this letter replaces Attachment A of LAR 292, Revision 0 (Reference 1) in its entirety.
- Attachment C contains only those Proposed ITS and Bases Changes that required changing from those presented in LAR 292, Revision 0 (Reference 1) to reflect the responses to the RAIs. These are presented in strikeout and shadowed text format and revision bar format. All other Proposed ITS and Bases Changes presented in Reference 1 remain valid for License Amendment Request #292.
- Attachment D includes a complete set of ITS and ITS Bases pages in Revision Bar format for the changes proposed in LAR 292, Revision 0 and Revision 1.
- Attachment E contains the proprietary version of Holtec Report Number HI-2022907, Revision 1, in response to the Request for Additional Information.
- By providing the report in Attachment E, Holtec International requests that the proprietary information in this submittal be withheld from public disclosure in accordance with 10 CFR 2.390(a)(4) and 10 CFR 2.390(d)(1). An affidavit supporting this request is provided in Attachment F.

Attachment B to the original submittal (Reference 1) documents the Regulatory Analysis which contains the No Significant Hazards Consideration Determination and the Environmental Impact Evaluation. The changes proposed to LAR 292 are clarifications which do not change to the intent of the initial submittal. As such, the No Significant Hazards Consideration Determination and the Environmental Impact Evaluation in Reference 1 remain valid.

CR-3 has two pools for fuel storage in the fuel handling area of the Auxiliary Building. Under present ITS requirements, fresh fuel must be stored in Pool A in a checkerboard pattern with empty water cells in the alternate locations. These empty water cells are therefore unavailable to store fuel. Similarly, some cell locations near the edge of both pools are inaccessible using current fuel handling equipment. Combining this loss of storage with the volume of spent fuel currently stored in these pools, prestaging of fresh fuel and off-loading the entire core during the upcoming refueling outage has become more complicated to execute. Rather than refuel under such constraints, this LAR has been prepared to redefine storage requirements in order to provide a more effective use of pool storage and flexibility for reloading activities. To accommodate the upcoming Fall 2007 refueling outage, FPC is requesting approval of this amendment by September 1, 2007, with a 30 day implementation period.

In accordance with 10 CFR 50.91, a copy of this application, with non-proprietary enclosures, is being provided to the designated Florida State Official.

This letter establishes no new regulatory commitments.

The CR-3 Plant Nuclear Safety Committee has reviewed this request and recommended it for approval.

If you have any questions regarding this submittal, please contact Mr. Paul Infanger, Supervisor, Licensing and Regulatory Programs at (352) 563-4796.

Sincerely,

Dale E. Young

Dale E. Young
Vice President
Crystal River Nuclear Plant

DEY/dar

Attachments:
- A. Request for Additional Information Response
- B. Description of the Proposed Change and Justification for the Request
- C. Proposed Improved Technical Specification and Bases Changes (Strikeout and Shadowed Text Format)
- D. Proposed Improved Technical Specification and Bases Changes (Revision Bar Format)
- E. Holtec Report Number HI-2022907, Revision 1, "Criticality Evaluation of CR3 Spent Fuel Pool Storage Racks with Mark B-12 Fuel" (Proprietary)
- F. Holtec International Affidavit for Withholding Proprietary Information from Public Disclosure

xc: NRR Project Manager
Regional Administrator, Region II
Senior Resident Inspector
State Contact

STATE OF FLORIDA

COUNTY OF CITRUS

Dale E. Young states that he is the Vice President, Crystal River Nuclear Plant for Florida Power Corporation, doing business as Progress Energy Florida, Inc.; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission the information attached hereto; and that all such statements made and matters set forth therein are true and correct to the best of his knowledge, information, and belief.

Dale E. Young

Dale E. Young
Vice President
Crystal River Nuclear Plant

The foregoing document was acknowledged before me this 19th day of July, 2007, by Dale E. Young.

Ellen Deppolder

Signature of Notary Public
State of Florida

ELLEN DEPPOLDER
MY COMMISSION # DD 408539
EXPIRES: July 8, 2009
Bonded Thru Notary Public Underwriters

(Print, type, or stamp Commissioned Name of Notary Public)

Personally Known ✓ -OR- Produced Identification ______

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

LICENSE AMENDMENT REQUEST #292, REVISION 1

ADDITIONAL STORAGE PATTERNS FOR CRYSTAL RIVER UNIT 3 STORAGE POOLS A AND B

ATTACHMENT A

REQUEST FOR ADDITIONAL INFORMATION RESPONSE

Request for Additional Information Response

On June 20, 2007, the Nuclear Regulatory Commission (NRC) issued a Request for Additional Information (RAI, Reference 15) concerning License Amendment Request (LAR) #292, Revision 0 (Reference 1). Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., hereby provides the following response to this RAI.

<u>NRC Request</u>

1. Not used.

<u>FPC Response</u>

1. No response is necessary.

<u>NRC Request</u>

2. The licensee has concluded that the proposed change does not involve a significant increase in the probability of occurrence or consequences of an accident previously evaluated. However, the information provided did not address a misloading or boron dilution event. Please provide the following information:

2a. Generally, will the new fuel storage configurations require more or fewer fuel moves than the current configuration (i.e., will the new configuration require more fuel shuffling or less)?

<u>FPC Response</u>

2a. The objective of the proposed change is to justify the storage of new fuel assemblies next to spent fuel in CR-3 Spent Fuel Pool A. The current configuration rules require checkerboarding new fuel with empty water holes. The proposed configuration rules will allow checkerboarding new fuel with spent fuel. Once approved, an initial set of fuel moves may occur to place surplus spent fuel near new fuel. After this, normal fuel movement will likely occur. The proposed change allows additional space and flexibility for fuel movement. This will eliminate the need to empty cells near new fuel regions prior to fuel receipt and allow the cooler new fuel region to be home to recently discharged fuel.

Without the proposed change, more shuffling is expected to accommodate new fuel shipments because of limited flexibility and space. While it cannot be stated conclusively that the proposed change will result in less fuel shuffling, this is expected to be one of the benefits.

<u>NRC Request</u>

2b. Does the new configuration require a more complex methodology to characterize fuel assemblies or to identify the correct storage rack locations?

<u>FPC Response</u>

2b. No. CR-3 currently takes credit for fuel assembly burnup in the existing version of CR-3 ITS LCO 3.7.15. The same methodology will be used to characterize the fuel assemblies and determine correct storage locations.

<u>NRC Request</u>

2c. Who identifies the correct location for a specific assembly?

<u>FPC Response</u>

2c. Fuel assembly burnup and storage class are determined and documented by a formal calculation, performed by the Progress Energy Corporate Pressurized Water Reactor Fuel Engineering group or CR-3 Reactor Engineering. Formal calculations such as these require verification by qualified personnel. A qualified reactor engineer uses the information in this calculation to initiate move sheets directing fuel storage. A second qualified reactor engineer or Senior Reactor Operator (SRO) verifies these move sheets prior to use.

<u>NRC Request</u>

2d. What barriers are in place to prevent a mislocation? For example, is there a written procedure or plan that delineates what is to be moved and in what sequence? Is there independent verification of the procedure or plan? Is there independent verification of each move?

<u>FPC Response</u>

2d. Move sheets constitute both a written procedure and a plan that designates initial and final location, and in what order the moves are to occur. Changes to the plan require changes to the move sheet which must be independently verified by a qualified Reactor Engineer or SRO. Procedure SNM-100, "Special Nuclear Materials Handling and Accountability Manual," provides direction on fuel storage requirements and dictates the method for move sheet initiation, verification and changes. Move sheets are generated using a form from the procedure. Once filled out, they are to be followed as a procedure. As stated in the answer to 2c above, move sheets require independent verification prior to use.

Fuel movement procedures (FP-203, "Defueling and Refueling Operations" and FP-601C, "Operation Of Spent Fuel Handling Bridge FHCR-3") also require a fuel movement spotter to provide independent verification of each fuel move. This consists of independent verification of proper bridge indexing (location) for both picking up and storing fuel assemblies.

<u>NRC Request</u>

2e. Should a fuel assembly be misloaded, how would the error be detected?

<u>FPC Response</u>

2e. CR-3 ITS LCO 3.7.14 requires maintaining greater than or equal to 1925 parts per million (ppm) boron in the spent fuel pools during fuel movement to provide additional safety margin for misloaded fuel. Prior to allowing the boron concentration to decrease when fuel movement is complete, a final verification of proper fuel loading is required by the LCO. Procedurally, this consists of a video verification of serial numbers to ensure the fuel was stored in the intended locations and configuration. If a fuel assembly were misloaded, this verification would detect the error.

However, a misloaded fuel assembly would most likely be identified even before this. A misloaded fuel assembly would create an empty rack cell in an improper location (where *the fuel assembly should have been stored), and eliminate an empty rack cell (where the assembly was incorrectly stored). With limited free space in the spent fuel pools, and with the periodic fuel shuffling requirements from recently implemented thermal limiting fuel patterns, the cell location vacated by one move will likely be filled by another fuel assembly shortly after. A misloaded fuel assembly would likely be discovered before completion of fuel moves when an intended fuel move could not be completed because the initial location of the move contained no assembly or the final location was not empty.*

Lastly, the primary changes to the criticality analysis, and the ones with the highest reactivity contribution involve the storage of new fuel assemblies with spent fuel assemblies in a regular, recognizable pattern. New fuel assemblies can be easily distinguished from spent fuel assemblies from their appearance. If a new or spent fuel assembly were placed in a wrong location, the irregularity of the pattern of new and spent fuel would become visibly evident indicating a potential abnormality.

NRC Request

2f. What barriers are in place to prevent a common mode human error in misloading several assemblies (i.e., an initial error followed by dependent errors, such as inadvertently sequencing the fuel moves incorrectly, or mis-identifying the assemblies or locations)?

FPC Response

2f. Each move can only influence the next in that it fills or empties a rack cell location making it available or unavailable for the next move. The move sheets systematically designate each location to pick up a fuel assembly and each location to deliver one. Each rack location in the spent fuel pool is independently marked by placards affixed to the bridge rails and to the sides of the pool. Since each move is initiated, completed and verified based on those affixed placards (and not the relative location of one storage cell to another), a mislocation of one fuel assembly will not cause a cascading effect on the following moves. Removing and replacing the indexing placards must be performed via the plant modification process which requires design review and testing to ensure proper installation. Additionally, Spent Fuel Coordinators are familiar with the configuration of the rack cells, and are capable of counting in both directions to cross-check and verify the placards following a modification that might have recently installed replacements.

NRC Request

3. Proposed TS Figure 3.7.15-2 lists the enrichment/burnup curves for determining storage configuration requirements in CR-3 Pool B. With respect to Figure 3.7.15-2, please provide the following information:

3a. The LAR has named all areas on Figures 3.7.15-1 and 3.7.15-2, except the area under the lowest curve on Figure 3.7.15-2. Why was this area not named?

FPC Response

3a. Naming of the various regions of the graph with respect to the curves was simply a designation convenience and had not been considered necessary for the region below both curves in Figure 3.7.15-2. Category F was used for the low burnup/high enrichment region in Figure 3.7.15-1, and no name was used for the low burnup/high enrichment *region in Figure 3.7.15-2. For consistency in labeling, the region of the graph below the curves in Figure 3.7.15-2 is now identified as Category BE.*

NRC Request

3b. Note 1 to Figure 3.7.15-2 states Category B fuel may be stored in any location without restriction. Note 3 to Figure 3.7.15-2 states fuel meeting the lower curve criteria can only be stored in Pool B if surrounded by eight empty water cells. Please provide clarification on this apparent contradiction, as Category B fuel assemblies cannot be stored in those empty storage cells.

FPC Response

3b. The intent was that Category B fuel could be stored in any location unless there was another restriction (e.g., Note 3) that prevented it. To avoid confusion, Note 1 is being altered in this submittal to clearly state that Category B fuel may be stored in any location without restriction except as noted below (referring to Note 3). This makes it clear that Category B fuel cannot be substituted for the empty cell requirements of Note 3.

A similar revision was made to Figure 3.7.15-1 to acknowledge the storage restrictions identified in Note 3 of that figure.

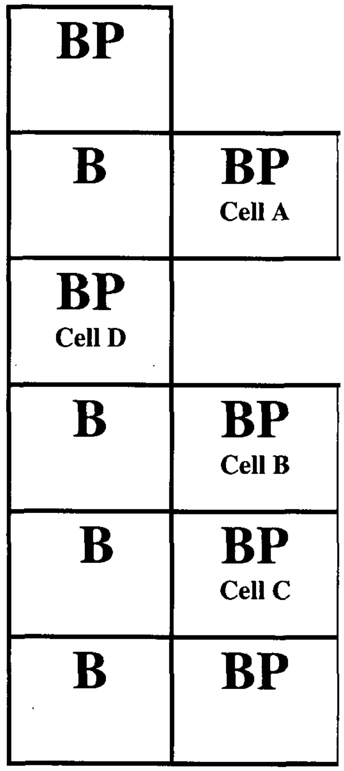
NRC Request

3c. Note 2 to Figure 3.7.15-2 states, Category BP fuel may be stored in peripheral cells. The definition of peripheral cells has been changed from the cells against the SFP wall to the last cell containing fuel. The last cell containing fuel could be in the middle of the SFP. Are there any restrictions on how far from the SFP wall a cell can be and still be considered a peripheral cell?

FPC Response

3c. Based on the results of the calculation, there are no specific restrictions on how far from the spent fuel pool wall that a cell can be considered a peripheral cell. However, the definition of a peripheral cell is being changed in this submittal to simplify the number of configurations that need to be evaluated as being bounded by the analysis. The Category BP description for Pool B has been revised to state that a peripheral cell is, "...defined as the outermost of the first two storage cells closest to the spent fuel pool wall that has a fuel assembly located in it. If the storage cell closest to the spent fuel pool wall is kept empty of fuel, then the second storage cell from the spent fuel pool wall may be filled with lower burnup fuel meeting the requirements of Category BP fuel." This means that Category BP assemblies can be placed in that second cell so long as the cell between it and the wall remains empty of fuel. Below, in Figure 1, is a diagram of the analyzed configuration and the proposed configurations allowed by the revised definition of peripheral cell. The cells are labeled for the type of stored fuel assembly: B (type B, higher burnup), BP (type BP, lower burnup) or E (empty of fuel).

Figure 1
Potential Configurations



Analyzed Configuration

B	BP	E
B	BP	E
B	BP	E
B	BP	E

The analyzed condition evaluated a BP assembly with two face-adjacent Category BP assemblies, one face-adjacent Category B assembly, two diagonally located Category B assemblies and one face-adjacent empty storage cell. For the proposed definition of peripheral cells, there are four potential configurations labeled Cell A, Cell B, Cell C and Cell D in Figure 1. The Category BP assembly in Cell A of Figure 1 would have one face-adjacent Category B fuel assembly, two diagonally located Category BP assemblies and two face-adjacent empty storage cells. Since the face-adjacent fuel assemblies have significantly more effect on reactivity than diagonally located fuel assemblies, the reactivity of the proposed configuration would have a lower reactivity than the analyzed configuration (i.e., two face-adjacent BP assemblies replaced by two diagonally located BP assemblies and two face adjacent empty cells). Similarly, Cell B would have one face-adjacent Category B fuel assembly, one face-adjacent Category BP assembly, one diagonally located Category BP assembly, one diagonally located Category B assembly and one face-adjacent empty storage cell. Again this configuration is bounded by the analyzed configuration because one face-adjacent Category BP assembly is replaced by a less reactive diagonally located Category BP assembly. Cell C is exactly equivalent to the analyzed configuration.

An assembly in Cell D would replace two Category BP face adjacent assemblies in the analyzed configuration with the much higher burnup, lower reactivity category B fuel, which would tend to decrease reactivity compared to the previously analyzed condition. A Cell D assembly would also have two diagonally located BP cells in place of two empty cells, which would tend to increase the reactivity compared to the previously analyzed condition. However, since face-adjacent cells have a much greater effect than diagonally located cells, the negative reactivity effect of the face-adjacent B assemblies would override the positive reactivity effect of the diagonally located BP assemblies.

<u>NRC Request</u>

4. When discussing the methodology used and specifically the MCNP4a computer code, Section 2 of HI-2063579 states, "Based on these studies, a minimum of 10,000 histories were simulated per cycle, a minimum of 100 cycles were skipped before averaging, a minimum of 150 cycles were accumulated, and the initial source was specified as uniform over the fueled regions (assemblies)." However, HI-2063579 Section 4 indicates axial blankets were explicitly modeled. Please reconcile this apparent contradiction.

<u>FPC Response</u>

4. Section 2 and Section 4 refer to different aspects of the analysis as follows:

- *Section 2 refers to the initial source distribution, which is part of the convergence control of the Monte-Carlo methodology. It affects the convergence of the calculation, i.e., how fast the result can be reached, but not the result itself. Using a uniform starting source distribution is a simple and acceptable approach. A non-uniform distribution could result in an improved performance. However, there is little if any benefit in doing so given the current use of faster computers. Nevertheless, this is an important parameter, since an inappropriate choice could result in a non-converged solution. As an example, choosing a point source at the bottom of the assembly instead of a source uniform over the fueled region could create convergence problems. Choosing the uniform source ensures that such convergence problems do not occur in these calculations.*

- *Section 4 refers to the physical modeling of fuel assemblies with axial blankets, stating that these blankets are considered in the model. It discusses the conservative approach in enrichments selected for these blankets.*

While both discussions address spatial modeling issues, they are not directly related. Therefore, there is no contradiction.

NRC Request

5. Not used.

FPC Response

5. No response is necessary.

NRC Request

6. HI-2063579 Section 5.1 refers to Table 5.1 for the fuel assembly design specifications. Table 5.1 does not contain any tolerance information for Mark B-10/B-9 for Mark B/HTP fuel assemblies. What tolerances were used for the Mark B-10/B-9 for Mark B/HTP fuel assemblies?

FPC Response

6. The fuel types B-10F and B-11 are the bounding fuel types (see Section 7.1.2 of Reference 7), in some cases with substantial margin (see Table 6-1 on page 25 of this attachment for fuel of 4.5% enrichment in Pool A). Fuel tolerances are only specified and analyzed for these bounding assembly types. For different assembly types, fuel tolerances are typically similar, and would therefore have a similar reactivity effect. Because the effect fuel tolerances have on reactivity are relatively similar for different fuel types, fuel tolerances really do not affect the choice of the bounding assembly types. Therefore, the approach of considering fuel tolerances only for the bounding assembly types is appropriate.

NRC Request

7. NUREG/CR-6665, "Review and Prioritization of Technical Issues Related to Burnup Credit for LWR Fuel" (Ref. 5), recommends using the maximum fuel and core outlet temperature. Table 5.2 indicates the average fuel and core outlet temperature was used in the analysis. Justify using less than the maximum fuel and core outlet temperature.

FPC Response

7. The temperatures used in the analysis for depletion calculations shown in Table 5.2 of Reference 7 are based on the values used in previous analyses for the CR-3 spent fuel pool. The fuel temperature used in the analysis of 1238°F bounds the maximum average fuel temperature of 1146°F. The core average moderator temperature at the top of the active fuel region is the highest temperature that any portion of the active fuel region would experience during reactor operation. These temperature values are applied over the entire length of the active fuel region, ensuring that the use of the temperatures in Table 5.2 is conservative.

<u>NRC Request</u>

8. HI-2063579 Sections 5.3 and 7.1.4 discuss the axial burnup distribution. The axial burnup profile for blanketed assemblies is provided in Table 5.3a. The axial burnup profile for non-blanketed assemblies is provided in Table 5.3b. NUREG/CR-6801, "Recommendations for Addressing Axial Burnup in PWR [pressurized-water reactor] Burnup Credit Analysis" (Ref. 3), reports the results of an analysis of the axial-burnup-profile database of Reference (Ref. 4). That database contains 3169 PWR axial profiles from 1700 different assemblies, which represent 3 fuel vendors, 20 different reactors, and 106 cycles of operation through the mid-1990s. NUREG/CR-6801 set expectations for the number of axial zones to be used in determining the axial burnup distribution and identified current bounding axial burnup distributions. The bounding axial burnup distributions were set by Babcock and Wilcox 15x15 profiles. With respect to the axial burnup distribution, provide the following information.

8a. The axial burnup profiles in Table 5.3a do not match those in NUREG/CR-6801. What is the source for the Table 5.3a axial burnup distribution profiles? What is the justification for using those profiles?

<u>FPC Response</u>

8a. The profiles listed in Table 5.3a are from CR-3 fuel assemblies and are representative of the fuel assemblies to be loaded. The profiles are therefore more appropriate than the profiles from NUREG/CR-6801. The main purpose of the NUREG is to provide axial profiles for dry transportation and storage applications, i.e., applications that are typically not site-specific. To this extent, a large number of possible profiles are analyzed in this NUREG to ensure all assemblies to be loaded in such systems are appropriately represented. For a site-specific analysis such as the analysis of a spent fuel pool, such an approach is not necessary, and could be overly conservative.

<u>NRC Request</u>

8b. Table 5.3a has twenty axial zones, the last of which ends at a core height of 357.46 cm. However, Footnote number 9 to Table 5.1 indicates that all fuel assemblies were modeled as 144 inches (365.46 cm). Please reconcile this apparent contradiction. How does this affect the analysis discussed in Section 7.1.4 and represented in Table 7.7?

<u>FPC Response</u>

8b. The axial burnup profiles presented in Table 5.3a in Reference 7 are for blanketed fuel assemblies. These are modeled with the axial segmentation listed in that table. The axial burnup profiles presented in Table 5.3b in Reference 7 are for non-blanketed fuel assemblies with an active length of 144 inches. The fresh fuel assembly is modeled with the same active fuel height as the blanketed or unblanketed assembly, as appropriate. This has no effect on the results in Table 7.7 in Reference 7 because all of the results presented in Table 7.7 are with an active fuel length of 357.46 cm (non-blanketed fuel). Additionally, this does not affect the conclusions of Section 7.1.4 of Reference 7, as the calculations with the non-blanketed fuel are performed with an active fuel length of 365.76 cm (144 inches). The difference in active fuel length between blanketed and non-blanketed fuel has a negligible effect on reactivity.

NRC Request

8c. Table 5.3b has 10 axial zones. NUREG/CR-6801 concluded that 10 axial zones are insufficient to adequately model the burnup distribution profile. No burnup dependency is indicated for the burnup profile in Table 5.3b. The axial burnup profile is typically burnup dependent. Provide the justification for the use of the axial burnup profile in Table 5.3b.

i. Note, NUREG/CR-6801 included S. E. Turner's, "An Uncertainty Analysis – Axial Burnup Distribution Effects" (Ref. 6), which is essentially the same Reference 9 in HI-2063579.

FPC Response

8c. The conclusion in NUREG/CR-6801 is for uniform axial discretizations, i.e., where all axial sections have the same height. In such a case, ten sections are insufficient. The segmentation in Table 5.3b, however, uses a non-uniform discretization with smaller sections at the top and bottom and larger sections in the middle. Using larger sections in the middle is appropriate for this application since the profile is practically flat in this area. At the top and bottom, the segment height is only six inches, (which would be equivalent to a 24 uniform segment profile for a 144 inch active region), which is sufficient. The axial segmentation of the profile is therefore appropriate.

The axial profile in Table 5.3b had been used in over twenty wet storage licensing applications reviewed and approved by the NRC. It is based on a burnup of about 30 GWd/mtU. It will therefore be bounding for assemblies with higher burnups, since axial profiles for higher burnup assemblies are flatter (see Table 5.3a). For assemblies with lower burnup, the case with a flat axial burnup profile, i.e., a constant burnup over the axial height of the assembly is typically bounding. Therefore, using a single profile is sufficient and conservative. Note that the profile in Table 5.3b is in fact very similar to the profiles in Table 2 of NUREG/CR-6801 for the burnup range of 30 to 34 GWd/mtU.

NRC Request

8d. HI-2063579 Section 7.1.4 states, "For Pool B, previous analysis [11] investigated the reactivity effect of non-blanketed fuel. The study showed that non-blanketed fuel, which has a maximum enrichment of 4.24 wt% 235U at the appropriate burnup for Category B, was found to be acceptable below the regulatory criteria of 0.95. These results are still applicable for the analysis presented in this report. Therefore, both blanketed and non-blanketed fuel is bounded by the flat distribution."

i. There is no reference 11 in Section 8 of HI-2063579. What is reference 11? If reference 11 is not on the NRC docket, provide a copy of reference 11 for NRC staff review. Upon review of this document the staff may have further questions as the concept that non-blanketed fuel assemblies are bounded by a flat distribution is contrary to current analysis.

FPC Response

8d. i. Reference [11] is a proprietary Holtec Report No HI-2022907, "Criticality Evaluation of CR3 Spent Fuel Pool Storage racks with Mark B-12 Fuel." This calculation is included as Attachment E to this letter. The text for reference [11] was not included in the licensing report (Reference 7). The context in which it appears is *a discussion about the previous calculation which analyzed the reactivity effect of axial blankets on Pool B. Holtec Report No HI-2022907 was implemented at CR-3 under the 50.59 process to allow a new fuel type to be stored in the spent fuel storage racks. The 50.59 evaluation, discussed on page 49 of Attachment B to the CR-3 Final Safety Analysis Report (FSAR) and 50.59 Report dated December 29, 2003, Reference 8, stated the Holtec Report No HI-2022907 was bounded by three other reports, which had already been submitted on the docket for CR-3. These other reports (References 10 through 12 of this letter) were docketed as attachments to References 13 and 14.*

Table 7.7 of Reference 7 shows the results of the calculations performed as part of this license amendment. For blanketed assemblies, the flat distribution produces bounding results compared to the axially distributed profiles in Table 5.3a. Table 8-1 of Reference 7 shows the results of the analysis comparing blanketed assemblies with a flat distribution (which is bounding for blanketed fuel) versus non-blanketed assemblies with the distribution in Table 5.3b.

NRC Request

8d. ii. What is the flat distribution being used?

FPC Response

8d. ii. The flat distribution assumes the assembly average burnup over the entire active fuel length.

NRC Request

8e. HI-2063579 Section 7.1.4 indicates an analysis was performed for Pool A that concluded, "...The conclusion is that the maximum k_{eff} with blanketed fuel and a flat axial burnup distribution bounds the maximum k_{eff} with non-blanketed fuel and the distribution shown in Table 5.3b. Therefore, use of the flat profile with axial blankets is conservative." Provide the results of that analysis.

FPC Response

8e. The results of the analysis, provided in Table 8-1 on page 26 of this attachment, confirm that the blanketed fuel with the flat profile bounds the non-blanketed fuel with the axial distribution in Table 5.3b of Reference 7.

NRC Request

8f. From the discussion in HI-2063579 Section 7.1.4 it is unclear which axial burnup profile is being used with the non-blanketed fuel assemblies. Clarify the use of the axial burnup profiles.

FPC Response

8f. All non-blanketed fuel assemblies were modeled with the axial burnup distribution in Table 5.3b of Reference 7. Calculations of blanketed assemblies with the axial burnup distributions from Table 5.3a of Reference 7 were compared to calculations of blanketed assemblies with a flat axial burnup distribution. The results in Table 7.7 of Reference 7 show that the flat axial burnup distribution with blanketed assemblies produces the highest reactivity. Therefore, all blanketed assemblies are modeled with a flat axial burnup distribution.

NRC Request

9. HI-2063579 Sections 5.4 and 7.1.3 discuss the effects of core inserts axial profile shaping rods (APSR) and burnable poison rod absorbers (BPRA). Tables 5.4, 5.5, and 5.6 provide some design specification information for the APSRs and BPRAs. No manufacturing tolerances for the APSRs and BPRAs are discussed. How would the manufacturing tolerances on the APSRs and BPRAs affect the analysis?

FPC Response

9. For the in-core operation, every assembly is assumed to have a BPRA during early assembly life and an APSR after that. This maximizes the reactivity effect of inserts during depletion. This is an extremely conservative assumption since only a small fraction of assemblies will be exposed to both a BPRA and an APSR, and an even smaller fraction would have a component inserted during its entire life in the core. This conservatism bounds the reactivity effect of tolerances for the inserted components.

NRC Request

10. HI-2063579 Section 5.5.1 and 5.5.2 describe the CR3- Pool A and Pool B SFP racks. Pool A is described as "...stainless steel walls sandwiching a Carborundum neutron absorber panel, centered on each side of the storage cell." Pool B is described as "...a single Boral neutron absorber panel affixed to the stainless steel walls of adjacent storage cells." With respect to the SFP storage racks, provide the following information.

10a. What is the stainless steel used in the walls of the storage cells and Boral sheathing?

FPC Response

10a. Spent Fuel Pool A storage cell walls are Type 304 stainless steel. The wrapper plate (the Boral sheathing) and the storage cell for Spent Fuel Pool B is Type 304L stainless steel.

The stainless steel composition is modeled as shown below:

Stainless Steel, ρ = 7.2 g/cc	
Element	***Atom Density (atoms/barn-cm)***
Chromium	*0.01761*
Manganese-55	*0.001761*
Iron	*0.05977*
Nickel	*0.008239*

The reactivity is not strongly dependent upon the composition of the steel, especially when fixed neutron absorbers are present.

NRC Request

10b. HI-2063579 Section 5.5 states, "Only the B_4C is credited in the composition of the Carborundum in the Pool A racks. This is conservative as it neglects the other components of the Carborundum which may absorb additional neutrons." How are the other components modeled?

<u>FPC Response</u>

10b. The other components of the Carborundum, other than B_4C, are modeled as void, i.e., they are neglected. The composition of the Carborundum used in the analysis is:

0.012 g $^{10}B/cm^2$ minimum plus a 15% loss of B_4C
0.048 inches thick Carborundum

Assume that the entire material is B_4C, all other constituents not present.

B_4C is composed of 78.26 weight percent Boron and 21.74 weight percent Carbon. Boron is assumed to be 18.1 weight percent ^{10}B and 81.9 weight percent ^{11}B.

$$\text{Density of } B_4C = \frac{(0.012 \text{ g } ^{10}B/cm^2) * (1.0-0.15)}{(0.181 \text{ g } ^{10}B/\text{g } B)*(0.7826 \text{ g } B/\text{g } B_4C)*(0.048 \text{ inches})*(2.54 \text{ cm/inch})}$$

Density of B_4C = 0.591 g/cm^3

Constituents are:
^{10}B = 14.17 weight percent
^{11}B = 64.09 weight percent
C = 21.74 weight percent

<u>NRC Request</u>

10c. HI-2063579 Section 5.5.1 states, "The Carborundum is additionally assumed to be partially degraded (15% loss of B_4C)." What is the basis for this assumption? Why is there no similar assumption for the Boral in the Pool B storage cells?

<u>FPC Response</u>

10c. When the Pool A racks were installed, it was assumed that some Carborundum loss might occur. A 15% loss margin is currently established in the surveillance procedure acceptance criteria. It was added to the calculation to preserve the adequacy of the current procedure criteria. Boral is a different poison material type that is not as susceptible to material loss as the Carborundum material. Boral is described in the CR-3 FSAR Section 1.4.66 as follows:

> *"Boral® is a metallic composite of a hot-rolled (sintered) aluminum matrix containing boron carbide (B_4C) sandwiched between and bonded to type 1100 alloy aluminum."*

Due to these differences, no similar loss was anticipated in the Boral poison. Therefore, a loss assumption for Boral was not required for the calculations for Pool B.

<u>NRC Request</u>

10d. HI-2063579 Section 5.5.2 discusses the potential in Pool B for misalignment between the Boral plates and the fuel assembly not sitting properly in the storage cell. Why isn't there a similar discussion for Pool A?

<u>FPC Response</u>

10d. The neutron absorber in Pool A is 159 inches long, which is significantly longer than the maximum active fuel length of 144 inches. Therefore, there is no potential for misalignment of the active fuel length and the neutron absorber in the Pool A racks.

<u>NRC Request</u>

10e. Boral's stainless steel sheathing cannot be discerned on Figure 5.3. Describe how the sheathing is modeled.

<u>FPC Response</u>

10e. Figure 5.3 in Reference 7 has been reproduced at a greater resolution and magnification to show the modeling of the Boral sheathing. This information is shown in Figure 5.3 (detail) on page 24 of this attachment.

<u>NRC Request</u>

11. Not used.

<u>FPC Response</u>

11. No response is necessary.

<u>NRC Request</u>

12. HI-2063579 Section 7.2.1 indicates for Pool A, eccentric positioning of the fuel assemblies in the closest proximity resulted in an equivalent k_{eff} as centering the assemblies within the storage cell.

12a. How were the storage cell tolerances applied on this analysis?

<u>FPC Response</u>

12a. The calculations to determine the reactivity effect of eccentric positioning were performed at the nominal storage cell dimensions. The reactivity effect of the storage cell tolerances are included in the calculation of the maximum k_{eff} values and therefore do not need to be considered here.

<u>NRC Request</u>

12b. Explain why moving the fuel closer together had no effect on reactivity. What was the result of moving the fuel farther apart?

<u>FPC Response</u>

12b. For the eccentric fuel positioning, the same model has been used in many previous licensing applications. It consists of an infinite array of cells, where in each neighboring group of four cells, the assemblies are moved closest together (i.e., assemblies are moved into the corner of the rack cells). Where assemblies are moved closer to those on two sides of a cell, they are also moved further apart on the other two sides of the cell. This configuration creates several competing effects. On the sides with closer proximity of the adjacent assemblies, the neutronic coupling between assemblies is increased. However, the amount of water between the assemblies (i.e., the moderation) is reduced. The increased neutronic coupling would increase k_{eff}, while the reduced moderation could result in a reduction of the k_{eff}. On the other side where assemblies are now located further apart, the opposite effects would occur, although not necessarily with the same quantitative effect on k_{eff}. The net effect of k_{eff} therefore depends on the conditions, specifically the rack type and presence of neutron poisons. Previous analyses have shown that for poisoned racks, the effect on k_{eff} is typically negative, while for unpoisoned racks the effect might be positive. In the current configuration, the effect is negligible.

NRC Request

13. HI-2063579 Section 7.2.2 describes the development of uncertainties due to manufacturing tolerances for the fuel assemblies and storage racks in Pool A. The fuel assembly tolerances are provided in Table 5.1 and the storage rack tolerances are provided in Tables 5.7 for Pool A. The resultant uncertainties are listed in Table 7.8. With respect to the development of uncertainties due to manufacturing tolerances, provide the following information.

13a. What were the configurations used to determine the uncertainties listed in Table 7.8? Were these infinite lattices of the individual assemblies or specific checkerboard configurations? How are the results dependent on the configuration used in the analysis?

FPC Response

13a. The reactivity effect of various manufacturing tolerances provided in Table 7.8 of Reference 7 was determined based on infinite array lattices of the specific assembly, enrichment and burnup as described in the table. The reactivity effect of manufacturing tolerances for the checkerboard configuration was then determined by selecting the maximum reactivity effect for either the spent fuel assembly or the fresh fuel assembly from the infinite array calculations. For the example presented in Table 7.8, the reactivity effect of the manufacturing tolerances associated with the checkerboard configuration containing spent fuel of 5.0 weight percent initial enrichment and burnup of 42.73 GWD/MTU are 0.0080 (maximum of 0.0080 and 0.0064) for the rack tolerances and 0.0042 (maximum of 0.0042 and 0.0041) for the fuel tolerances. For other burnup and enrichment combinations of the spent fuel assembly (as shown in Table 5.9 of Reference 7, Category B), the reactivity effect of manufacturing tolerances at that burnup and enrichment were calculated and compared to the reactivity effect of manufacturing tolerances for the fresh fuel. The maximum reactivity effect was then selected and applied to the calculation of the maximum k_{eff}.

NRC Request

13b. HI-2063579 Section 7.2.2 indicates calculations are performed for different enrichments and burnups. What combinations of enrichments and burnups were used for each fuel type? Are the uncertainties listed in Table 7.8 the bounding uncertainties?

FPC Response

13b. The combinations of burnups and enrichments for the spent fuel assembly in the checkerboard configuration are shown in Table 5.9 of Reference 7 for Category B fuel. The spent fuel assembly is based on Mark B-10F, which is shown to be the bounding assembly for Category B fuel in Table 7.3 of Reference 7. The fresh fuel assembly is based on the Mark B-11 fuel assembly, which is shown to be the bounding assembly for fresh fuel in Table 7.3. The uncertainties presented in Table 7.8 of Reference 7 are the bounding uncertainties for the checkerboard of fresh fuel with spent fuel having an initial enrichment of 5.0 weight percent with a burnup of 42.73 GWD/MTU. The uncertainties listed in Table 7.8 are bounding for this burnup and enrichment combination of the spent fuel.

NRC Request

13c. HI-2063579 Section 7.2.2 indicates the full tolerance was used to determine the maximum reactivity effect. Were sensitivity studies performed to confirm whether the maximum or minimum dimension, after application of the tolerance, provided the maximum positive reactivity effect?

FPC Response

13c. Sensitivity studies were performed to confirm whether the maximum or minimum dimension produced an increase in reactivity, except in the case where the positive reactivity trend is known (i.e., increased enrichment, increased fuel density). Only the positive reactivity effects are presented in Table 7.8 of Reference 7.

NRC Request

13d. Deleted.

FPC Response

13d. No response is necessary.

NRC Request

14. HI-2063579 Section 7.2.3 describes the development of SFP temperature bias for Pool A. The results are listed in Table 7.9 and indicate Pool A has a negative moderator temperature coefficient. What were the configurations used to determine the biases listed in Table 7.9? Were these infinite lattices of the individual assemblies or specific checkerboard configurations? How are the results dependent on the configuration used in the analysis?

FPC Response

14. The reactivity effect of temperature variation provided in Table 7.9 of Reference 7 were determined based on infinite array lattices of the specific assembly, enrichment and burnup as described in the table. The temperature bias for the checkerboard configuration (as shown in Table 7.1 of Reference 7) was then determined by selecting the maximum temperature bias for either the spent fuel assembly or the fresh fuel assembly from the infinite array calculations. For the example presented in Table 7.9, the temperature bias associated with the checkerboard configuration containing spent fuel of 5.0 weight percent initial enrichment and burnup of 42.73 GWD/MTU is 0.0012 (maximum of 0.0007 and 0.0012). For other burnup and enrichment combinations of the spent fuel assembly (as shown in Table 5.9 of Reference 7, Category B), the temperature bias at that burnup and enrichment was calculated and compared to the temperature bias for the fresh fuel. The maximum temperature bias was then selected and applied to the calculation of the maximum k_{eff}. This will conservatively bound the temperature bias for the checkerboard configuration.

NRC Request

15. Not used.

FPC Response

15. No response is necessary.

NRC Request

16. HI-2063579 Section 7.2.5.4.1 describes the analysis to determine the soluble boron required to offset the possible misloading of a fuel assembly in Pool A.

16a. Provide a description of the controls that ensure the misloading of only a single fuel assembly need be considered.

FPC Response

16a. As discussed in more detail in the response to Question 2, move sheets dictating the move locations and sequence are created by qualified individuals, and then independently verified by another qualified individual. The moves are then made by a qualified individual and to prevent misloadings, independently verified by another. As stated earlier, a single misloading quickly reveals itself because a rack cell location is incorrectly filled and another rack cell location is incorrectly left empty. Since each move is verified against installed placards, a single misloading is prevented from leading to other misloadings. Even without verification, a misloading would become evident when a later move is blocked by the out of position fuel assembly.

It is worth noting that though it is highly improbable for multiple fuel assembly misloadings to occur, there is significant reactivity margin available. CR-3 ITS LCO 3.7.14 requires a minimum boron concentration of 1925 ppm during fuel movement in the spent fuel pool. However, only 165 ppm is required to maintain k_{eff} less than 0.95 for a misloaded fuel assembly in Pool A, and 46 ppm is required for a misloaded fuel assembly in Pool B (Section 1.0 of Reference 7). This provides a margin of at least 1760 ppm boron to absorb additional misloaded fuel assemblies to maintain a k_{eff} of less than 0.95. An additional 0.05 (approximately 5% Δ k/k) margin still remains to criticality.

Therefore, though it is highly improbable that multiple fuel assemblies would be misloaded, the boron requirement of CR-3 ITS LCO 3.7.14 provides a significant safety margin capable of absorbing the impact of additional misloaded fuel assemblies.

NRC Request

16b. Provide the results of the various enrichment and burnup combinations that were used in the analysis.

FPC Response

16b. The results of the misloading analysis for various enrichment and burnup combinations for Pool B are presented in Table 16-1 on page 27 of this attachment.

NRC Request

16c. Were any analyses performed for the misloading of a fuel assembly in the boundary between the Category B and fresh fuel checkerboard and the Category A storage? If there were, provide the results of those analyses or explain why no analyses were performed.

FPC Response

16c. No analysis of a misloaded assembly in the boundary between the checkerboard configuration and the Category A storage was performed. The misloading analysis was performed with a fresh, unburned assembly misloaded into a storage cell intended to be *used for spent fuel in the checkerboard arrangement. The misloaded assembly is directly face-adjacent to four other fresh fuel assemblies. If an assembly were misloaded in a storage location in the boundary between the checkerboard configuration and the Category A storage, the misloaded assembly would be face-adjacent to one fresh fuel assembly, one Category A assembly (low burnup - 5.0 weight percent, 10 GWD/MTU), and two Category B assemblies (high burnup - 5.0 weight percent, 42.73 GWD/MTU). Therefore, the misloaded configuration analyzed is considered bounding.*

NRC Request

16d. Provide the results of the analysis used to determine the soluble boron requirement.

FPC Response

16d. The results of the misloading analysis, including the determination of the soluble boron requirement is provided in Table 16-1 on page 27 of this attachment. The final soluble boron amount is determined by linear interpolation between the maximum k_{eff} calculated for 0 ppm and 400 ppm for each burnup and enrichment combination.

NRC Request

17. HI-2063579 Section 7.3.1 indicates for Pool B, eccentric positioning of the fuel assemblies in the closest proximity resulted in an equivalent k_{eff} as centering the assemblies within the storage cell.

17a. How were the storage cell tolerances applied in this analysis?

FPC Response

17a. The calculations to determine the reactivity effect of eccentric positioning were performed at the nominal storage cell dimensions. The reactivity effect of the storage cell tolerances are included in the calculation of the maximum k_{eff} values and therefore do not need to be considered here.

NRC Request

17b. Explain why moving the fuel closer together had no effect on reactivity. What was the result of moving the fuel farther apart?

FPC Response

17b. For the eccentric fuel positioning, the same model has been used in many previous licensing applications. It consists of an infinite array of cells, where in each neighboring group of four cells the assemblies are moved closest together, (i.e., assemblies are moved into the corner of the rack cells). Where assemblies are moved closer to those on two sides of a cell, they are also moved further apart on the other two sides of the cell. This configuration creates several competing effects. On the sides with closer proximity to the adjacent assemblies, the neutronic coupling between assemblies is increased. However, the amount of water between these assemblies (i.e., the moderation) is reduced. The increased neutronic coupling would increase k_{eff}, while the reduced moderation could result in a reduction of the k_{eff}. On the other side where assemblies are now located further apart, the opposite effects would occur, although not necessarily with the same quantitative effect on k_{eff}. The net effect of k_{eff} therefore depends on the conditions, specifically the rack type and presence of neutron poisons. Previous analyses have *shown that for poisoned racks the effect on k_{eff} is typically negative, while for unpoisoned racks the effect might be positive. In the current configuration, the effect is negligible.*

<u>NRC Request</u>

18. HI-2063579 Section 7.3.2 describes the development of uncertainties due to manufacturing tolerances for the fuel assemblies and storage racks in Pool B. The fuel assembly tolerances are provided in Table 5.1 and the storage rack tolerances are provided in Tables 5.8 for Pool B. The resultant uncertainties are listed in Table 7.10. With respect to the development of uncertainties due to manufacturing tolerances, provide the following information.

18a. What were the configurations used to determine the uncertainties listed in Table 7.10? Were these infinite lattices of the individual assemblies or a specific configuration? How are the results dependent on the configuration used in the analysis?

<u>FPC Response</u>

18a. The reactivity effect of various manufacturing tolerances provided in Table 7.10 of Reference 7 was determined based on infinite array lattices of the specific assembly, enrichment and burnup as described in the table. The reactivity effect of manufacturing tolerances for the configuration shown in Figure 5.3 of Reference 7 was then determined by selecting the maximum reactivity effect for either the spent fuel assembly or the fresh fuel assembly from the infinite array calculations. For the example presented in Table 7.10, the reactivity effect of the manufacturing tolerances associated with the configuration shown in Figure 5.3 containing spent fuel of 5.0 weight percent initial enrichment and burnup of 42.73 GWD/MTU are 0.0080 (maximum of 0.0080 and 0.0064) for the rack tolerances and 0.0042 (maximum of 0.0042 and 0.0041) for the fuel tolerances. For other burnup and enrichment combinations of the spent fuel assembly (as shown in Table 5.9 of Reference 7, Category B), the reactivity effect of manufacturing tolerances at that burnup and enrichment were calculated and compared to the reactivity effect of manufacturing tolerances for the fresh fuel. The maximum reactivity effect was then selected and applied to the calculation of the maximum k_{eff}.

<u>NRC Request</u>

18b. HI-2063579 Section 7.3.2 indicates calculations are performed for different enrichments and burnups. What combinations of enrichments and burnups were used for each fuel type? Are the uncertainties listed in Table 7.10 the bounding uncertainties?

<u>FPC Response</u>

18b. The combinations of burnups and enrichments for the spent fuel assembly in the configuration shown in Figure 5.3 of Reference 7 (see also Figure 5.3 (detail) on page 24 of this attachment) are shown in Table 5.9 of Reference 7 for Category B fuel. The spent fuel assembly is based on the Mark B-10F fuel assembly, which is shown to be the bounding assembly for Category B fuel in Table 7.4 of Reference 7. The fresh fuel assembly is based on the Mark B-11 fuel assembly, which is shown to be the bounding assembly for fresh fuel in Table 7.4. The uncertainties presented in Table 7.10 of Reference 7 are the bounding uncertainties for the Figure 5.3 configuration of fresh fuel with surrounding spent fuel having an initial enrichment of 5.0 weight percent with a *burnup of 42.73 GWD/MTU. The uncertainties listed in Table 7.8 are bounding for this burnup and enrichment combination of the spent fuel.*

NRC Request

18c. HI-2063579 Section 7.3.2 indicates the full tolerance was used to determine the maximum reactivity effect. Were sensitivity studies performed to confirm whether the maximum or minimum dimension, after application of the tolerance, provided the maximum positive reactivity effect?

FPC Response

18c. Sensitivity studies were performed to confirm whether the maximum or minimum dimension produced an increase in reactivity, except in the case where the positive reactivity trend is known (i.e., increased enrichment, increased fuel density). Only the positive reactivity effects are presented in Table 7.10 of Reference 7.

NRC Request

19. HI-2063579 Section 7.3.3 describes the development of SFP temperature bias for Pool B. The results are listed in Table 7.11 and indicate Pool B has a negative moderator temperature coefficient. What were the configurations used to determine the biases listed in Table 7.11? Were these infinite lattices of the individual assemblies or specific checkerboard configurations? How are the results dependent on the configuration used in the analysis?

FPC Response

19. The reactivity effect of temperature variation provided in Table 7.11 of Reference 7 were determined based on infinite array lattices of the specific assembly, enrichment and burnup as described in the table. The temperature bias for the configuration shown in Figure 5.3 of Reference 7 (as shown in Table 7.2 of Reference 7) was then determined by selecting the maximum temperature bias for either the spent fuel assembly or the fresh fuel assembly from the infinite array calculations. For the example presented in Table 7.11, the temperature bias associated with the Figure 5.3 configuration containing spent fuel of 5.0 weight percent initial enrichment and burnup of 42.73 GWD/MTU is 0.0030 (maximum of 0.0021 and 0.0030). For other burnup and enrichment combinations of the spent fuel assembly (as shown in Table 5.9 of Reference 7, Category B), the temperature bias at that burnup and enrichment was calculated and compared to the temperature bias for the fresh fuel. The maximum temperature bias was then selected and applied to the calculation of the maximum k_{eff}. This will conservatively bound the temperature bias for the configuration shown in Figure 5.3.

NRC Request

20. HI-2063579 Section 7.3.4 describes the development of maximum k_{eff} for Pool B. The model used for the analysis is shown in Figures 5.3 and 5.4. Figure 5.4 is a representative sketch of the storage cell. Figure 5.3 is a drawing representative of a fresh fuel assembly bordered by eight empty storage cells, which in turn are bordered by Category B fuel assemblies.

20a. Figure 1.2 shows two arrangements of a fresh fuel assembly bordered by eight empty storage cells bordering each other and not separated by four rows of

Category B fuel assemblies as would be the case in the model represented by Figure 5.3. What is the maximum k_{eff} in this arrangement?

FPC Response

20a. *The maximum k_{eff} of the configuration in Figure 1.2 of Reference 7 (two fresh fuel assemblies, each surrounded by eight empty storage locations) was not explicitly modeled. The two fresh fuel assemblies would be neutronically decoupled from each other as they are separated by at least 18 inches (rack pitch is 9.11 inches). The additional empty storage locations would offset the reactivity effect of the additional fresh fuel assembly. Therefore, the proposed configuration in Figure 1.2 would be bounded by the analyzed condition.*

NRC Request

20b. According to the definition and restrictions of Category B and Category BP fuel assemblies in the proposed revised TS Figure 3.7.15-2 the empty cells could be bordered on two sides by Category BP fuel assemblies instead of Category B fuel assemblies. What is the maximum k_{eff} if the Category B are replaced with Category BP fuel assemblies?

FPC Response

20b. *The proposed configuration (replacing Category B fuel with Category BP fuel on two sides around the fresh fuel assembly) would be bounded by the analyzed condition as described in Section 7.3 of Reference 7. The Category BP fuel is only allowed on the rack periphery, where there is an inherent radial neutron leakage. The radial neutron leakage would offset the reactivity effect of the lower burned Category BP fuel assemblies.*

NRC Request

21. HI-2063579 Section 7.3.5.4.1 describes the analysis to determine the soluble boron required to offset the possible misloading of a fuel assembly in Pool B.

21a. Provide a description of the controls that ensure the misloading of only a single fuel assembly need be considered.

FPC Response

21a. *As discussed in more detail in the response to Question 2, move sheets dictating the move locations and sequence are created by qualified individuals, and then independently verified by another qualified individual. The moves are then made by a qualified individual and to prevent misloadings, independently verified by another. As pointed out earlier, a single misloading quickly reveals itself because a rack cell location is incorrectly filled and another rack cell location is incorrectly left empty. Since each move is verified against installed placards, a single misloading is prevented from cascading to multiple misloadings. Additionally, a misloading would become evident when a later move is blocked by the out of position fuel assembly.*

It is worth noting that though it is highly improbable for multiple fuel assembly misloadings to occur, there is significant reactivity margin available. CR-3 ITS LCO 3.7.14 requires a minimum boron concentration of 1925 ppm during fuel movement in the spent fuel pool. However, only 165 ppm is required to maintain k_{eff} less than 0.95 for a *misloaded fuel assembly in Pool A, and 46 ppm is required for a misloaded fuel assembly in Pool B (Section 1.0 of Reference 7). This provides a margin of at least 1760 ppm boron to absorb additional misloaded fuel assemblies to maintain a keff of less than 0.95. An additional 0.05 (approximately 5% Δ k/k) margin still remains to criticality.*

Therefore, though it is highly improbable that multiple fuel assemblies would be misloaded, the boron requirement of CR-3 ITS LCO 3.7.14 provides a significant safety margin capable of absorbing the impact of additional misloaded fuel assemblies.

NRC Request

21b. Provide the results of the various enrichment and burnup combinations that were used in the analysis.

FPC Response

21b. The results of the misloading analysis for various enrichment and burnup combinations are presented in Table 21-1 on page 28 of this attachment.

NRC Request

21c. It is presumed that the 7x7 array used for this analysis is the same 7x7 array used to determine the maximum k_{eff} for Pool B as depicted in Figure 5.3.

FPC Response

21c. Correct. Figure 5.3 is the correct model for the misloading accident in Pool B except for the presence of the misloaded assembly which is not shown in the figure.

NRC Request

21c. i. Which empty cell produced the maximum k_{eff} for the misloading analysis?

FPC Response

21c. i. The analysis was performed with the misloaded fresh fuel assembly placed in a storage cell intended to remain empty that is face-adjacent to the normally located fresh fuel assembly. Placing the two fresh fuel assemblies face-adjacent to one another will produce the most reactive configuration.

NRC Request

21c. ii. How would changing the configuration as described in question 20 above change the results?

FPC Response

21c. ii. The condition of misplacing a fresh fuel assembly between the two normally located fresh fuel assemblies (20a) or between the normally located fresh fuel assembly and Category BP fuel (20b) will not have a significant effect on reactivity. As discussed in the response to Question 20, these configurations are bounded by the analyzed condition, providing further assurance of the conservatism of the analyzed configuration. Additionally, there is a significant level of soluble boron present in the spent fuel pool, as required by the CR-3 ITS, ensuring the maximum reactivity will remain less than 0.95.

NRC Request

21d. Provide the results of the analysis used to determine the soluble boron requirement.

FPC Response

21d. The results of the misloading analysis, including the determination of the soluble boron requirement for Pool B are presented in Table 21-1 on page 28 of this attachment. The final soluble boron amount is determined by linear interpolation between the maximum k_{eff} calculated for 0 ppm and 400 ppm for each burnup and enrichment combination.

NRC Request

22. HI-2063579 Section 7.5 describes the change in definition of a 'peripheral cell' for Pool B. The definition of a 'peripheral cell' is changed from "...those that are adjacent to the walls of the spent fuel pool" to "...the outermost row of cells in the pool containing fuel assemblies." With the new definition a 'peripheral cell' could be in the center of the SFP, and perhaps back-to-back with a 'peripheral cell' from the each side of the SFP. The discussion in HI-2063579 Section 7.5 refers to Figure 1.2, which shows the outer most row, BT, completely empty and the next row in, BS, completely filled with Category BP fuel assemblies. The discussion indicates this is bounded by the previous analysis, which used a 30-centimeter water reflector for the periphery. While both scenarios would yield similar results, they do not represent other potential arrangements that would be allowed by the revised definition of a 'peripheral cell.' Under the current definition and the arrangements depicted in Figure 1.2 a Category BP fuel assembly is bordered on one side by at least three empty storage cells, one face-to-face and two diagonally. Under the new definition a Category BP fuel assembly may be placed in an arrangement such that is would only be bordered by one empty storage cell, face-to-face, while the previously empty diagonal storage cells may be filled with either Category B or BP fuel assemblies. It is not clear that these potential arrangements were considered in the analysis. Provide the analyses to show these potential arrangements are acceptable.

FPC Response

22. The proposed revision to the definition of peripherals cells is to accommodate additional flexibility in spent fuel loading in the racks. The previous definition only allowed Category BP fuel assemblies to be stored in rack storage cells that are closest to the spent fuel pool wall. If those storage cells are inaccessible or remain empty, the second row of storage cells may not be utilized to store lower burnup assemblies. The revision to the definition allows for Category BP fuel assemblies to be placed in the second row of storage cells from the spent fuel pool wall, if the associate cell in the first row remains empty.

As stated in the response to RAI #3, the definition of "Peripheral cell" is being revised to limit the number of configurations that need to be evaluated. These configurations were evaluated in the response to RAI #3 and were determined to be bounded by the configurations in the analysis of Reference 7.

References

1. Crystal River Unit 3 to NRC Letter, 3F1006-01, dated October 5, 2006, "Crystal River Unit 3 - License Amendment Request # 292, Revision 0, Additional Storage Patterns for Crystal River Unit 3 Storage Pools A and B" (ADAMS ML062830073)
2. NRC Memorandum dated August 19, 1998, "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants" (ADAMS MLOO3728001)
3. NUREG/CR-6801, "Recommendations for Addressing Axial Burnup in PWR Burnup Credit Analysis" (ADAMS ML0311 0292)
4. R. J. Cacciapouti and S. Van Volkinburg, "Axial Burnup Profile Database for Pressurized Water Reactors," YAEC-1937, Yankee Atomic Electric Company (May 1997) (Available from the Radiation Safety Information Computational Center at Oak Ridge National Laboratory as DLC-201)
5. NUREG/CR-6665, "Review and Prioritization of Technical Issues Related to Burnup Credit for LWR Fuel" (ADAMS MLOO3688150)
6. S. E. Turner, "An Uncertainty Analysis -Axial Burnup Distribution Effects," Proc. Workshop Use of Burnup Credit in Spent Fuel Transport Casks, Washington D. C. February 21-22, 1988, SAND89-0018, TTC-O884, UC-820, T. L. Sanders, Ed., Sandia National Laboratories, October 1989
7. Holtec Report No. HI-2063579 dated September 20, 2006, "Licensing Report for Additional Loading Patterns in Crystal River Unit 3 Pools A and B"
8. Crystal River Unit 3 to NRC Letter, 3F1203-16, dated December 29, 2003, "Final Safety Analysis Report, Revision 28 and 10 CFR 50.59 Report"
9. Holtec Report No. HI-2022907, Revision 1 dated September 25, 1992, "Criticality Evaluation of CR3 Spent Fuel Pool Storage Racks with Mark B-12 Fuel"
10. Holtec Report No. HI-931111, "Criticality Safety Evaluation of the Pool A Spent Fuel Storage Racks in Crystal River Unit 3 with Fuel of 5.0% Enrichment"
11. Holtec Report No. HI-992128, "Criticality Safety Analysis of the Westinghouse Spent Fuel Storage Racks in Pool B of Crystal River Unit 3"
12. Holtec Report No. HI-992285, "Criticality Safety Analysis of the Crystal River Unit 3 Pool A for Storage of 5 Percent Enriched Mark B-11 Fuel in Checkerboard Arrangement with Water Holes"
13. Crystal River Unit 3 to NRC Letter, 3F0395-09, dated March 9, 1995, "Technical Specification Change Request No. 201, Supplement 1 (Fuel Enrichment Increase)"
14. Crystal River Unit 3 to NRC Letter, 3F0999-07, dated September 16, 1999, "License Amendment Request #239, Revision 0, Enhanced Spent Fuel Storage"
15. NRC to Crystal River Unit 3 Letter dated June 20, 2007, "Crystal River, Unit No. 3, Request for Additional Information Regarding Additional Storage Patterns for Spent Fuel Pools (TAC No. MD3308)"

<u>Figure 5.3 (detail): Detail of a Two-Dimensional Representation of the Actual Calculation Model Used for the Pool B Rack Analysis for Loading of Fresh Fuel Surrounded by Empty Storage Cell Locations</u>

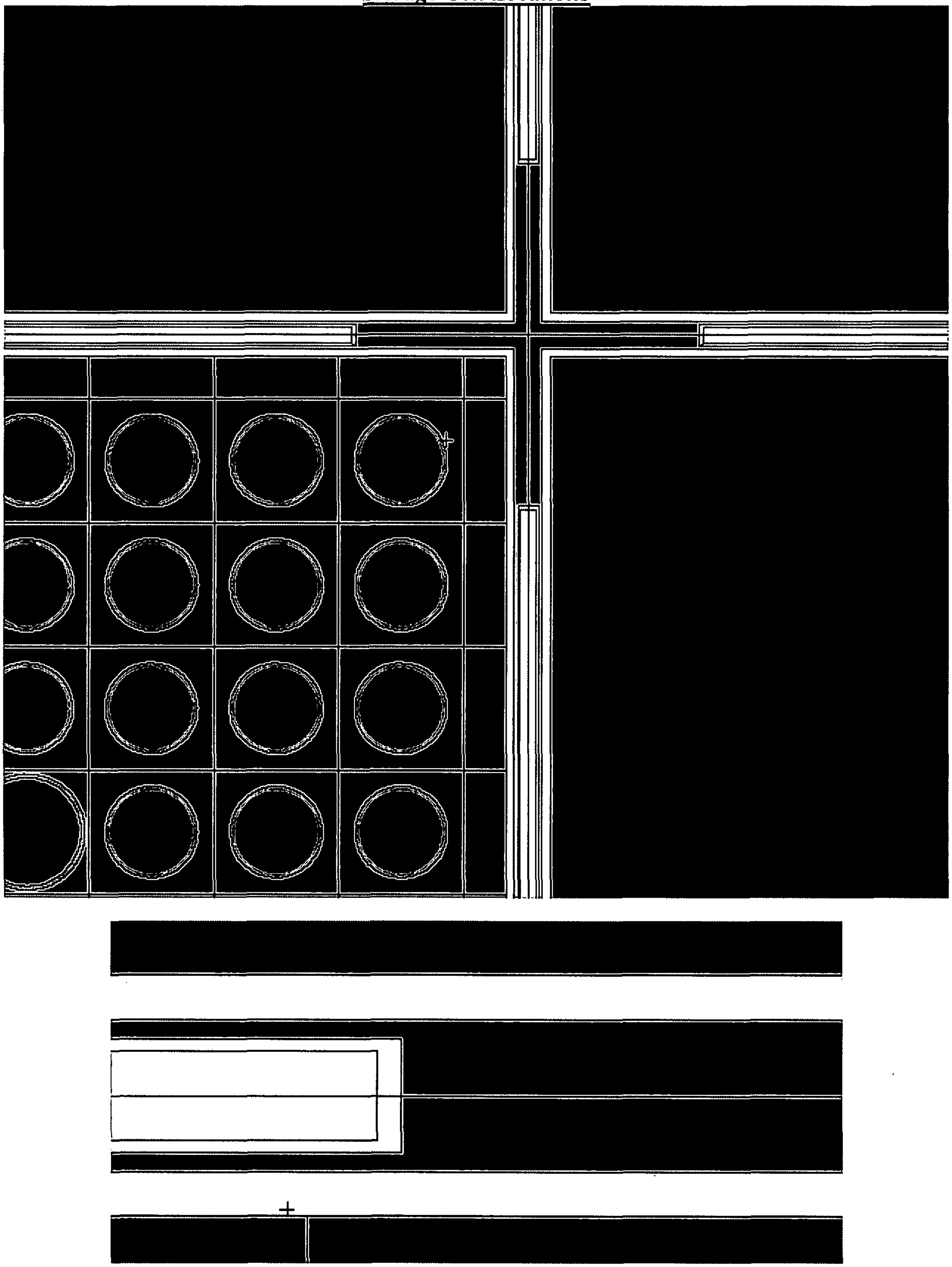


Table 6-1: Reactivity Comparison of Different Fuel Types for an Enrichment of 4.5 % in Pool A (k_{eff})

Burnup (MWd/MTU)	*Assembly Type*				*Maximum*
	b10f	*b10n9*	*b11*	*bhtp*	
0.0	*0.99088*	*0.98801*	***0.99870***	*0.99054*	*0.99870*
0.1	*0.98918*	*0.98631*	***0.99698***	*0.98883*	*0.99698*
0.5	*0.98287*	*0.98005*	***0.99066***	*0.98253*	*0.99066*
1.0	*0.97828*	*0.97550*	***0.98613***	*0.97794*	*0.98613*
2.0	*0.97158*	*0.96887*	***0.97948***	*0.97124*	*0.97948*
3.0	*0.96500*	*0.96234*	***0.97294***	*0.96466*	*0.97294*
4.0	*0.95830*	*0.95570*	***0.96628***	*0.95797*	*0.96628*
5.0	*0.95156*	*0.94900*	***0.95955***	*0.95123*	*0.95955*
6.0	*0.94485*	*0.94233*	***0.95282***	*0.94452*	*0.95282*
7.0	*0.93821*	*0.93570*	***0.94612***	*0.93788*	*0.94612*
8.0	*0.93165*	*0.92918*	***0.93949***	*0.93133*	*0.93949*
9.0	*0.92520*	*0.92272*	***0.93293***	*0.92488*	*0.93293*
10.0	*0.91885*	*0.91638*	***0.92645***	*0.91853*	*0.92645*
11.0	*0.91259*	*0.91012*	***0.92004***	*0.91228*	*0.92004*
12.5	*0.90340*	*0.90090*	***0.91057***	*0.90309*	*0.91057*
15.0	*0.88852*	*0.88597*	***0.89515***	*0.88823*	*0.89515*
17.5	*0.87398*	*0.87135*	***0.87997***	*0.87370*	*0.87997*
20.0	*0.85978*	*0.85702*	***0.86501***	*0.85950*	*0.86501*
22.5	*0.84586*	*0.84296*	***0.85022***	*0.84560*	*0.85022*
25.0	*0.83213*	*0.82907*	***0.83556***	*0.83188*	*0.83556*
27.5	*0.81857*	*0.81531*	***0.82098***	*0.81833*	*0.82098*
30.0	*0.80514*	*0.80169*	***0.80646***	*0.80492*	*0.80646*
32.5	*0.79186*	*0.78818*	***0.79199***	*0.79165*	*0.79199*
35.0	***0.77873***	*0.77480*	*0.77760*	*0.77854*	*0.77873*
37.5	***0.76577***	*0.76156*	*0.76327*	*0.76559*	*0.76577*
40.0	***0.75296***	*0.74847*	*0.74906*	*0.75280*	*0.75296*
42.5	***0.74036***	*0.73557*	*0.73500*	*0.74021*	*0.74036*
45.0	***0.72798***	*0.72289*	*0.72114*	*0.72786*	*0.72798*

<u>Table 8-1: Pool A Calculations, Blanketed versus Non-blanketed fuel</u>

Enrichment	5.0	5.0
Burnup (Category B)	42.73	42.73
	Blanketed Fuel	Non-blanketed fuel
Profile	flat	Holtec (Table 5.3b)
k-calc	0.9302	0.9265
stan dev	0.0006	0.0007
Bias		
Bias	0.0009	0.0009
Temperature	0.0012	0.0012
Total Bias	*0.0021*	*0.0021*
Uncertainties		
Bias	0.0011	0.0011
Calculational (2*sigma)	0.0012	0.0014
Eccentricity	0.0000	0.0000
Rack Tolerances	0.0080	0.0080
Fuel Tolerances	0.0042	0.0042
Depletion Uncertainty	0.0042	0.0044
Total Uncertainties	*0.0101*	*0.0102*
Total Addition	0.0123	0.0124
Maximum k_{eff}	**0.9425**	**0.9389**

Table 16-1: Calculation of Minimum Soluble Boron for Misloading Accident for Pool A

Enrichment	2.0		2.5		3.0		3.5		4.0		4.5		5.0	
Soluble Boron	0	400	0	400	0	400	0	400	0	400	0	400	0	400
Burnup (Category B)	6.41	6.41	13.26	13.26	19.56	19.56	25.47	25.47	31.94	31.94	37.46	37.46	42.73	42.73
k-calc	0.9515	0.9015	0.9520	0.9027	0.9508	0.9031	0.9502	0.9018	0.9511	0.9045	0.9526	0.9049	0.9517	0.9055
stan dev	0.0007	0.0006	0.0006	0.0007	0.0006	0.0006	0.0007	0.0007	0.0006	0.0006	0.0006	0.0007	0.0006	0.0006
Bias														
Bias	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
Temperature	0.0019	0.0019	0.0014	0.0014	0.0013	0.0013	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
Total Bias	*0.0028*	*0.0028*	*0.0023*	*0.0023*	*0.0022*	*0.0022*	*0.0021*	*0.0021*	*0.0021*	*0.0021*	*0.0021*	*0.0021*	*0.0021*	*0.0021*
Uncertainties														
Bias	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Calculational	0.0014	0.0012	0.0012	0.0014	0.0012	0.0012	0.0014	0.0014	0.0012	0.0012	0.0012	0.0014	0.0012	0.0012
Eccentricity	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rack Tolerances	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080
Fuel Tolerances	0.0058	0.0058	0.0050	0.0050	0.0046	0.0046	0.0044	0.0044	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042
Depletion	0.0006	0.0006	0.0012	0.0012	0.0020	0.0020	0.0026	0.0026	0.0033	0.0033	0.0038	0.0038	0.0042	0.0042
Total	*0.0101*	*0.0101*	*0.0097*	*0.0097*	*0.0096*	*0.0096*	*0.0097*	*0.0097*	*0.0098*	*0.0098*	*0.0100*	*0.0100*	*0.0101*	*0.0101*
Total Addition	0.0129	0.0129	0.0120	0.0121	0.0118	0.0118	0.0118	0.0118	0.0119	0.0119	0.0121	0.0121	0.0123	0.0123
Maximum k_{eff}	***0.9644***	***0.9144***	***0.9640***	***0.9148***	***0.9626***	***0.9149***	***0.9620***	***0.9136***	***0.9630***	***0.9164***	***0.9647***	***0.9170***	***0.9640***	***0.9178***
		Target		Target		Target		Target		Target		Target		Target
		0.9450		0.9450		0.9450		0.9450		0.9450		0.9450		0.9450
Soluble Boron		**155**		**155**		**147**		**141**		**155**		**165**		**164**

Table 21-1: Calculation of Minimum Soluble Boron for Misloading Accident for Pool B

Enrichment	2.0		2.5		3.0		3.5		4.0		4.5		5.0	
Soluble Boron	0	400	0	400	0	400	0	400	0	400	0	400	0	400
Burnup (Category B)	6.41	6.41	13.26	13.26	19.56	19.56	25.47	25.47	31.94	31.94	37.46	37.46	42.73	42.73
k-calc	0.9281	0.8775	0.9307	0.8829	0.9330	0.8854	0.9326	0.8880	0.9292	0.8847	0.9292	0.8872	0.9290	0.8885
stan dev	0.0005	0.0006	0.0005	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0006	0.0006	0.0006	0.0005	0.0006
Bias														
Bias	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Temperature	0.0035	0.0035	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Total Bias	*0.0044*	*0.0044*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*	*0.0039*
Uncertainties														
Bias	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Calculational	0.0010	0.0012	0.0010	0.0012	0.0012	0.0012	0.0012	0.0010	0.0010	0.0012	0.0012	0.0012	0.0010	0.0012
Eccentricity	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rack Tolerances	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078
Fuel Tolerances	0.0072	0.0072	0.0063	0.0063	0.0059	0.0059	0.0056	0.0056	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
Depletion	0.0022	0.0022	0.0052	0.0052	0.0075	0.0075	0.0095	0.0095	0.0113	0.0113	0.0125	0.0125	0.0136	0.0136
Total	*0.0110*	*0.0110*	*0.0114*	*0.0114*	*0.0124*	*0.0124*	*0.0136*	*0.0136*	*0.0149*	*0.0149*	*0.0158*	*0.0158*	*0.0167*	*0.0167*
Total Addition	0.0153	0.0153	0.0153	0.0153	0.0163	0.0163	0.0175	0.0175	0.0188	0.0188	0.0197	0.0197	0.0206	0.0206
Maximum k_{eff}	***0.9434***	***0.8928***	***0.9460***	***0.8982***	***0.9493***	***0.9017***	***0.9501***	***0.9055***	***0.9480***	***0.9035***	***0.9489***	***0.9069***	***0.9496***	***0.9091***
		Target		Target		Target		Target		Target		Target		Target
		0.9450		0.9450		0.9450		0.9450		0.9450		0.9450		0.9450
Soluble Boron		**-12**		**8**		**36**		**46**		**27**		**37**		**45**

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

LICENSE AMENDMENT REQUEST #292, REVISION 1

ADDITIONAL STORAGE PATTERNS FOR
CRYSTAL RIVER UNIT 3 STORAGE POOLS A AND B

ATTACHMENT B

DESCRIPTION OF THE PROPOSED CHANGE
AND JUSTIFICATION FOR THE REQUEST

DESCRIPTION OF THE PROPOSED CHANGE AND JUSTIFICATION FOR THE REQUEST

DESCRIPTION OF PROPOSED CHANGE:

The proposed amendment to the Crystal River Unit 3 (CR-3) Improved Technical Specifications (ITS) revises the defined pool burnup-enrichment requirements, storage configuration for fresh fuel and low burnup/high enriched fuel, the definition of a peripheral assembly, and will include minor editorial changes. The revisions to Limiting Conditions for Operation (LCO) 3.7.15 and the ITS Bases are as follows:

A. LCO Section 3.7.15, "Spent Fuel Assembly Storage"

1. Figure 3.7.15-1, "Burnup versus Enrichment Curve for Spent Fuel Storage Pool A." This figure defines acceptability of fuel assembly storage in Pool A based on burnup and the original fuel enrichment. The amendment proposes to add a new burnup/enrichment curve, identifies the different areas of the figure by a category, and adds notes to describe storage restrictions for fuel from the subdivided areas of the graph. General format changes were also made to remove a redundant title and to similarly format Figures 3.7.15-1 and -2.
   - The area above the new, upper curve is defined on the figure to be Category B. The added note states that fuel from this category can be stored with no restrictions except as noted below (referring to restrictions placed on other fuel types stored nearby).
   - The area between the upper and lower curves is defined on the figure to be Category A. The added note states that fuel from this category can be stored with fuel from Category A or B. No further configuration restrictions are necessary.
   - The area below the lower curve is defined on the figure to be Category F. The added note states that fuel from this category must be stored in a one-out-of-two checkerboard configuration with Category B fuel or empty water cells, and that fuel stored in this fashion must be separated from Category A fuel by a transition row of Category B fuel.

2. Figure 3.7.15-2, "Burnup versus Enrichment Curve for Spent Fuel Storage Pool B." This figure defines acceptability of fuel assembly storage in Pool B based on burnup and the original fuel enrichment. The amendment proposes to add notes to describe storage restrictions for fuel from the subdivided areas in the figure, similar to Figure 3.7.15-1. General format changes were also made to remove a redundant title and to similarly format Figures 3.7.15-1 and -2.
   - The area above the upper curve is defined on the figure to be Category B. The added note states that fuel from this category can be stored with no restrictions except as noted below (referring to restrictions placed on other fuel types stored nearby).
   - The area between the upper and lower curves is defined on the figure to be Category BP. The added note states that fuel from this category can be stored in peripheral rack cells.

- The area below the lower curve is defined on the figure to be Category BE. Fuel from this area of the figure is unacceptable for storage unless surrounded by eight empty water cells. A note relating this has been added to the graph and as a footnote.
- An additional note is added to the table stating that fuel of any enrichment and burnup including fresh, unburned fuel may be stored in Pool B if surrounded by eight empty water cells. Also added was the clarification that Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B.

B. Bases Section B 3.7.14, "Spent Fuel Pool Boron Concentration"

The report from the previous analysis is currently listed as a reference for this section. To complete this list of references, the Holtec report from the current analysis was added.

C. Bases Section B 3.7.15, "Spent Fuel Assembly Storage"

1. In the BACKGROUND section, the new reference is included in the text for the criticality analysis supporting these changes. Text has been deleted that indicated fresh fuel could only be stored in Pool A. Text has been added indicating that fuel up to 5.0 weight percent U-235 and sufficient burnup can be stored in Pool B provided it is stored in the correct storage configuration. Text is also added stating that new and low burnup fuel may be stored in Pool B provided it is surrounded by empty water cells, and that this is primarily for, but not limited to, performing fuel inspection and reconstitution activities.

2. In the APPLICABLE SAFETY ANALYSES section, the verb in the first sentence is changed from "are" to "is" (grammar change to support subject/verb agreement), and a new reference is added in the text for the new criticality analysis supporting these changes.

3. In the LCO section, the discussion of Pool A will be revised to reflect the addition of another curve to Figure 3.7.15-1. The statement that says Figure 3.7.15-1 has two burnup-enrichment regions that will be revised to three regions. Description will be added consistent with the changes made to the figure. Specifically, the three areas of the figure are described, categorized and storage requirements assigned:
   - Category B is assigned to the area of the figure above the upper curve which describes the higher burnup and enrichment assemblies. Fuel from this area of the figure has no storage restrictions except as noted below (referring to restrictions placed on the other fuel categories). This is clarified in the text by stating fuel from this area of the figure can be placed next to fuel from anywhere in the figure provided there are no restrictions on that fuel type preventing it. A statement is also included to show that Category B is defined by the same burnup-enrichment requirements for both Pools A and B (both figures).

- Category A is assigned to the area of the figure between the upper and lower curves. Text is added to show that fuel from this area of the figure can be stored next to fuel that falls in this category or in Category B with no further restrictions.
- Category F is assigned to the area of the figure beneath the lower curve. Text is added to show that fuel from this section of the figure needs to be stored in a one-out-of-two checkerboard configuration with either empty water cells or fuel from Category B in the alternate positions. Text is also added stating that fuel configured in this checkerboard pattern will be separated from areas of fuel from Category A by a transition row of fuel from Category B. Reference to the new calculation is also included.

4. LCO section of 3.7.15 BASES discussion of Pool B will be revised to describe the three regions in the figure, similar to the changes done for the Pool A except that the regions in Pool B are designated Categories B, BP and BE. The existing description of a periphery cell is also redefined. Existing text stating the peripheral cells are *"...those that are adjacent to the walls of the spent fuel pool"* is changed to *"...defined as those storage cells closest to the spent fuel pool wall that have fuel assemblies located in them. Therefore, if the storage cell closest to the spent fuel pool wall is kept empty, then the second storage cell from the spent fuel pool wall may be filled with lower burnup fuel meeting the requirements of Category BP fuel."* Also, the last sentence stating that fuel with low burnup and high enrichment cannot be put in Pool B is revised to allow storage of Category BE fuel (low burnup and high enrichment) in Pool B provided it be surrounded by eight empty water cells. Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B (i.e., none of the eight empty cells can be shared with another category BE fuel assembly).

5. LCO 3.7.15 BASES REFERENCES section will be revised by adding the new Holtec report supporting the previously noted revisions.

BACKGROUND

CR-3 has two spent fuel pools, designated as Pool A and Pool B. They are physically joined together through a transfer canal. Pools A and B are currently licensed to store fuel assemblies that conform to burnup-enrichment requirements specified in ITS Figures 3.7.15-1 and -2. Pool A is currently licensed to store fresh fuel assemblies in a checkerboard arrangement (fresh fuel assemblies alternating with empty water cells). Amendment 193, dated September 13, 2000, introduced the checkerboard arrangement for storing fresh fuel in Pool A as well as the current burnup and enrichment limits for Pool B. Margin to accidental criticality is maintained in both pools by meeting the regulatory requirement of a k_{eff} less than 0.95. In this amendment, the storage location for fresh fuel was moved from Pool B to A and the required arrangement was this checkerboard pattern. When fresh fuel is prestaged during refueling, empty storage space must be committed to support the checkerboard pattern. Consequently, this space is no longer available for storage. To recover these lost cells, a new criticality analysis has been performed by Holtec International. The new analysis reclaims these empty locations by replacing the empty water cells in the checkerboard pattern with spent fuel assemblies. This configuration no longer requires tying up empty storage locations. To improve usability of Pool A, the new analysis also demonstrated that the rest of Pool A could be freed up with no configuration requirements on higher burnup fuel if a row of higher burnup assemblies is used as a transition row around a checkerboarded area of fresh fuel.

The storage location for fresh fuel was moved from Pool B to Pool A in Amendment 193. This arrangement no longer allows fuel inspection or repair activities on fresh or low burnup fuel to be carried out in Pool B. This is undesirable. It is more efficient for these activities to be performed in Pool B simultaneously with refueling activities in Pool A. To allow this, an analysis was performed to demonstrate that a k_{eff} less than 0.95 can be maintained with a fresh fuel assembly of 5.0 weight percent placed in Pool B, provided the new assembly is surrounded by eight empty water cells. This means Pool B is safe to use for fresh fuel inspection or repair activities provided the fuel is stored in the proper configuration.

Current CR-3 ITS LCO and BASES require fuel with certain burnup-enrichment characteristics to be stored in peripheral cells of the pool. The BASES define a periphery cell to be located adjacent to the walls of the spent fuel pools. Some of these locations are not actually accessible using current fuel handling equipment. As such, a new analysis was performed to verify that these burnt assemblies could be safely stored in the outermost row of storage cells in the pool that contain a fuel assembly (rather than just in the row at the edge of the pool). This introduces more storage locations for these burnt assemblies. The definition of peripheral cells in the CR-3 ITS is therefore requested to change from "those that are adjacent to the walls of the spent fuel pool" to "defined as the outermost of the first two storage cells closest to the spent fuel pool wall that has a fuel assembly located in it. If the storage cell closest to the spent fuel pool wall is kept empty of fuel, then the second storage cell from the spent fuel pool wall may be filled with lower burnup fuel meeting the requirements of Category BP fuel." A clarification was also added that states "Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B" to assure that none of the eight empty cells are shared between Category BE fuel assemblies.

Due to the loss of storage capacity associated with existing fresh fuel checkerboard requirements and inaccessible peripheral cells, and due to the amount of fuel already stored in the spent fuel pools, prestaging of fresh fuel and off-loading the entire core during the upcoming refueling outage has become more complicated to execute. Rather than refuel under such constraints, this proposed amendment has been prepared to redefine storage requirements to provide a more effective use of pool storage and flexibility for reloading activities. Consequently, CR-3 is requesting approval of this amendment by September 1, 2007, to accommodate the upcoming Fall 2007 outage.

JUSTIFICATION FOR THE REQUEST

A criticality analysis of fresh fuel storage configurations in Spent Fuel Pools A and B was performed by Holtec International. A proprietary copy of the report documenting the calculation, "Licensing Report for Additional Loading Patterns in Crystal River Unit 3 Pools A and B," was provided in Reference 2. The calculations assumed fuel to have a maximum initial enrichment of 5.0 weight percent U-235. For normal conditions, no soluble boron was assumed in the pool water. For accident conditions, soluble boron was assumed consistent with the current CR-3 ITS methodology. Similarly, burnup is credited in determining acceptable storage consistent with current CR-3 ITS methodology. Both Pool A and Pool B continue to use the already existing burnup and enrichment correlations in Figures 3.7.15-1 and -2. The new analysis adds additional configurations and redefines periphery cells as noted below.

Pool A

The Pool A criticality analysis was performed to evaluate the acceptability of loading fresh 5.0 weight percent fuel in a one-out-of-two checkerboard configuration in Pool A with spent fuel meeting the same burnup-enrichment requirements as that needed for unrestricted storage in Pool B. The existing requirement is to checkerboard the fresh fuel with empty water cells. A transitional row of fuel meeting Pool B burnup-enrichment requirements was also modeled to separate fuel stored in compliance with current Pool A restrictions and the fresh/spent fuel checkerboard storage area. The report addresses both normal and accident conditions for these additional Pool A loading patterns. The analysis validated acceptability of these two new storage configurations, specifically:

- Storing fresh fuel in a one-out-of-two checkerboard configuration with spent fuel meeting the Category B unrestricted storage burnup and enrichment curve, and
- Using fuel of Category B requirements to transition between the checkerboard pattern and the fuel stored in accordance with current Category A requirements.

The maximum reactivity of the Pool A racks with fresh fuel of 5.0 weight percent initial enrichment stored in this checkerboard configuration, including the transitional row of Category B restricted fuel, was determined to be k_{eff} less than 0.95. This checkerboard configuration in Pool A is the proposed method for fresh fuel storage. Figure 1.1 of Reference 2 Attachment A represents the intended pattern. This is not intended to restrict fresh fuel storage to the particular cells shown, only to illustrate the patterns and the intended transition between the checkerboard region and the current Pool A storage region. The burnup-enrichment limits for fuel storage in Pool A are specified in revised ITS Figure 3.7.15-1.

Pool B

The Pool B criticality analysis by Holtec International presented in Attachment A of Reference 2 evaluated the criticality of fresh fuel, or fuel not meeting current burnup and enrichment requirements, stored in Pool B surrounded by eight empty water cells. The intention is to allow activities in Pool B, such as inspection and repair of fuel, that do not meet current Pool B storage requirements. Figure 1.2 of the Holtec analysis represents the intended storage pattern for such activities. This representation is not intended to restrict fuel storage to a particular cell shown, but to illustrate the intended patterns of fresh fuel surrounded by empty water cells. The analysis also addressed a new definition for peripheral cell storage and determined that from a reactivity and criticality aspect, the definition of periphery cell storage can be safely changed from *"those that are adjacent to the walls of the spent fuel pool"* to *"defined as the outermost of the first two storage cells closest to the spent fuel pool wall that has a fuel assembly* *located in it. If the storage cell closest to the spent fuel pool wall is kept empty of fuel, then the second storage cell from the spent fuel pool wall may be filled with lower burnup fuel meeting the requirements of Category BP fuel."* Figure 1.2 of the Holtec analysis similarly shows the analyzed periphery storage locations to be the outermost row of fuel assemblies in the pool. Again, this representation is not to assign specific pool locations as peripheral storage. No change to the burnup-enrichment limits was necessary for unrestricted storage or for peripheral cell storage in ITS Figure 3.7.15-2, but clarifying statements were added.

Analyses confirm fuel with initial enrichments up to 5.0 weight percent can be safely stored in the identified configurations with a k_{eff} less than 0.95 percent with 95 percent probability at a 95 percent confidence level. This includes calculation and manufacturing uncertainties, and assumes fuel conforms to burnup-enrichment limits defined by ITS Figures 3.7.15-1 and -2.

Details of the methodology used in the criticality analysis associated with this proposed license amendment can be found in Attachment A of Reference 2.

Thermal-Hydraulic Analysis

The submittal for the previously approved License Amendment Request #239 (Reference 3) discussed the ability of the spent fuel pool and spent fuel system to handle the maximum expected pool heat load, based on the increase in number of rack cells with the re-rack of Pool B. It concluded that the maximum heat load for the pool was based on off-loading a recent reactor core. As such, the existing ITS allows the pool to be filled with spent fuel, including a recent full core off-load. This submittal does not change the amount of heat from a full core off-load or the number of rack cell locations over that assumed in existing analysis. Therefore, it does not increase the heat load above that previously used to determine pool and spent fuel system acceptability.

Seismic Concerns

There is no seismic concern. The spent fuel storage racks are designed to Seismic Class I requirements. The proposed changes in this amendment introduce no rack modifications that would invalidate the previous analysis. Currently, fresh fuel must be checkerboarded with empty water cells. The proposed change allows checkerboarding with spent fuel assemblies. The current CR-3 ITS already allows all rack positions to be filled with spent fuel assemblies if no fresh fuel is present. Changing the definition of peripheral cell location will not affect the seismic qualification. Since the racks are already seismically qualified to be fully loaded with spent fuel, they will also be seismically qualified if the empty water cells in the checkerboard pattern are filled with spent fuel assemblies.

Fuel Handling Accidents

Fuel Handling Accidents (FHAs), as discussed in Section 14.2.2.3 of the CR-3 Final Safety Analysis Report (FSAR), assume a fuel assembly is dropped and damaged such that the gap gas activity of all 208 fuel rods is released. The changes requested by this submittal do not affect the structure of either fuel handling equipment or the fuel storage racks. No new handling strategies are being introduced. No new accident probabilities are introduced, no additional hazards are added. These changes only introduce fresh and spent fuel storage patterns that still maintain k_{eff} less than 0.95. The changes allow fresh fuel to be loaded next to spent fuel instead of empty water cells. However, storage configuration is not an input to or assumption of the FHA. Therefore, no changes are made to or needed in the FHA described in Section 14.2.2.3 of the FSAR.

Risk Considerations

The proposed amendment is not a risk-informed change. The operation of the system will be the same as is currently considered in the existing CR-3 Probabilistic Risk Analysis.

References

1. Crystal River Unit 3 to NRC Letter dated October 5, 2006, "Crystal River Unit 3 - License Amendment Request #292, Revision 0: Additional Storage Patterns for Crystal River Unit 3 Storage Pools A and B"
2. Crystal River Unit 3 to NRC Letter dated April 4, 2007, "Crystal River Unit 3 - Response to Request for Additional Information Re: License Amendment Request #292, Revision 0, 'Additional Storage Patterns for Crystal River Unit 3 Storage Pools A and B"
3. Crystal River Unit 3 to NRC Letter dated September 16, 1999, "License Amendment Request #239, Revision 0, Enhanced Spent Fuel Storage"
4. NRC Letter to Crystal River Unit 3 dated December 1, 1999, "Notice of Consideration of Issuance of Amendment to Facility Operating License, Proposed No Significant Hazards Consideration Determination, and Opportunity for Hearing - Crystal River Unit 3 (TAC No. MA6754)"

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

LICENSE AMENDMENT REQUEST #292, REVISION 1

ADDITIONAL STORAGE PATTERNS FOR CRYSTAL RIVER UNIT 3 STORAGE POOLS A AND B

ATTACHMENT C

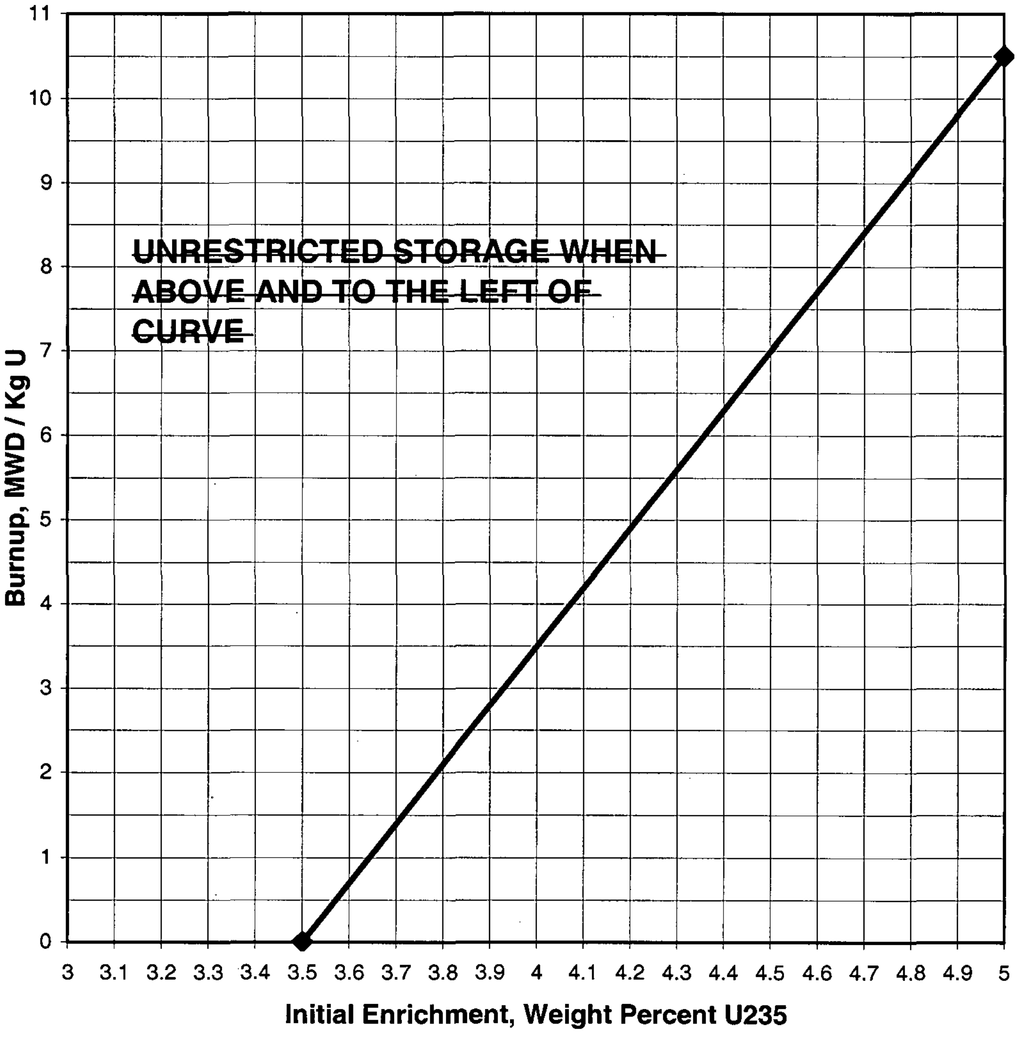
PROPOSED IMPROVED TECHNICAL SPECIFICATION AND BASES CHANGES (STRIKEOUT AND SHADOWED TEXT FORMAT)

~~Strikeout text~~ indicates deleted text.
Highlighted text indicates added text.

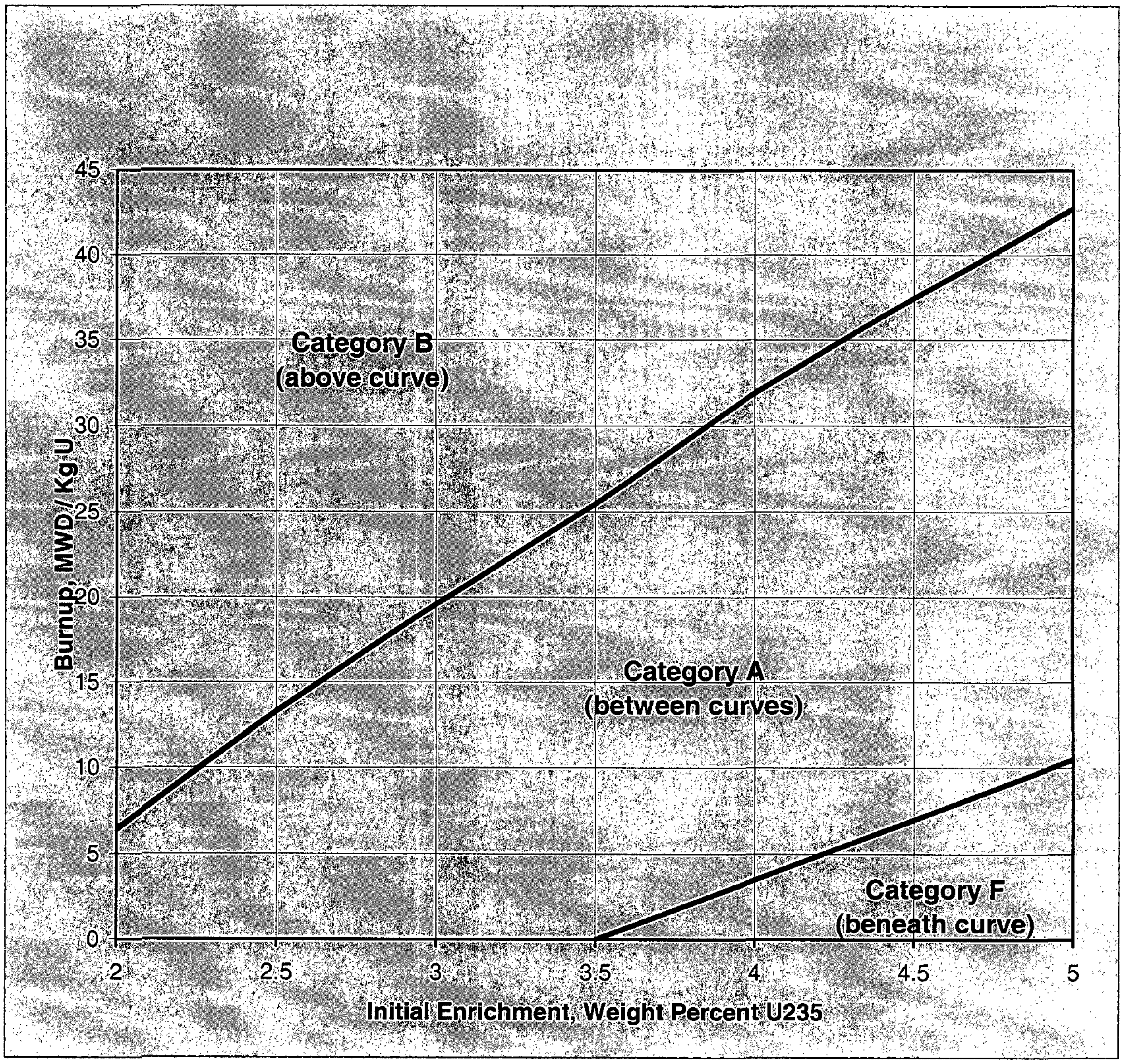
~~MINIMUM BURNUP REQUIRED FOR
"A" POOL STORAGE~~

~~NOTE: One out of two checkerboard loading with empty cells allowed for any combination of enrichment and burnup.~~

(REPLACE ENTIRE GRAPH)



~~Figure 3.7.15-
Burnup versus Enrichment Curve for
Spent Fuel Storage Pool~~



1. Category B: Fuel from this category can be stored with no restrictions except as noted below.
2. Category A: Fuel from this category can be stored with fuel from Categories A or B.
3. Category F: Fuel from this category must be stored in a one-out-of-two checkerboard configuration with fuel from Category B or empty water cells. Category F fuel stored in a checkerboard pattern with either Category B fuel or empty water cells must be separated from Category A fuel by a transition row of Category B fuel.

Figure 3.7.15-1
Burnup versus Enrichment Curve for
Spent Fuel Storage Pool A

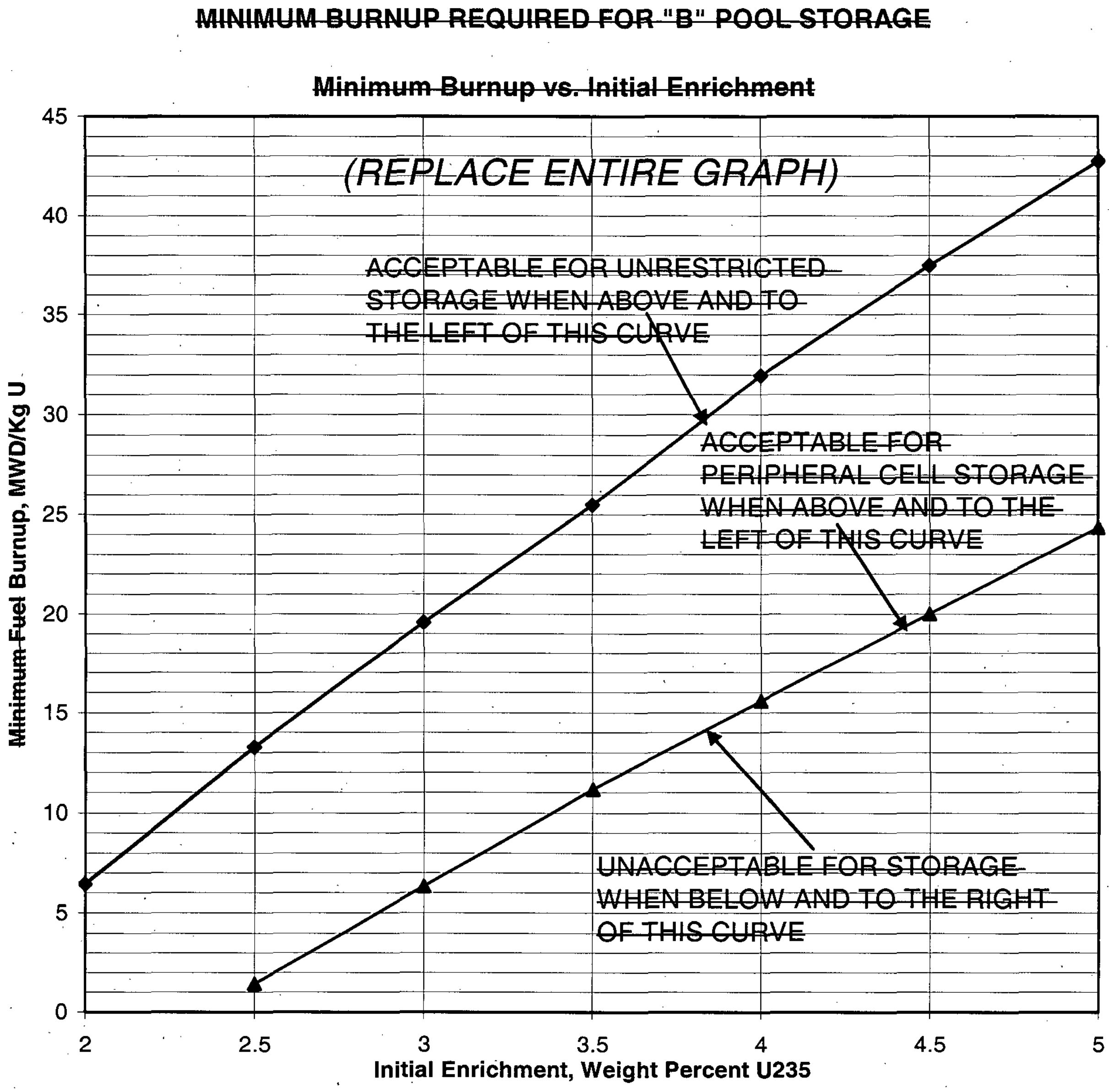
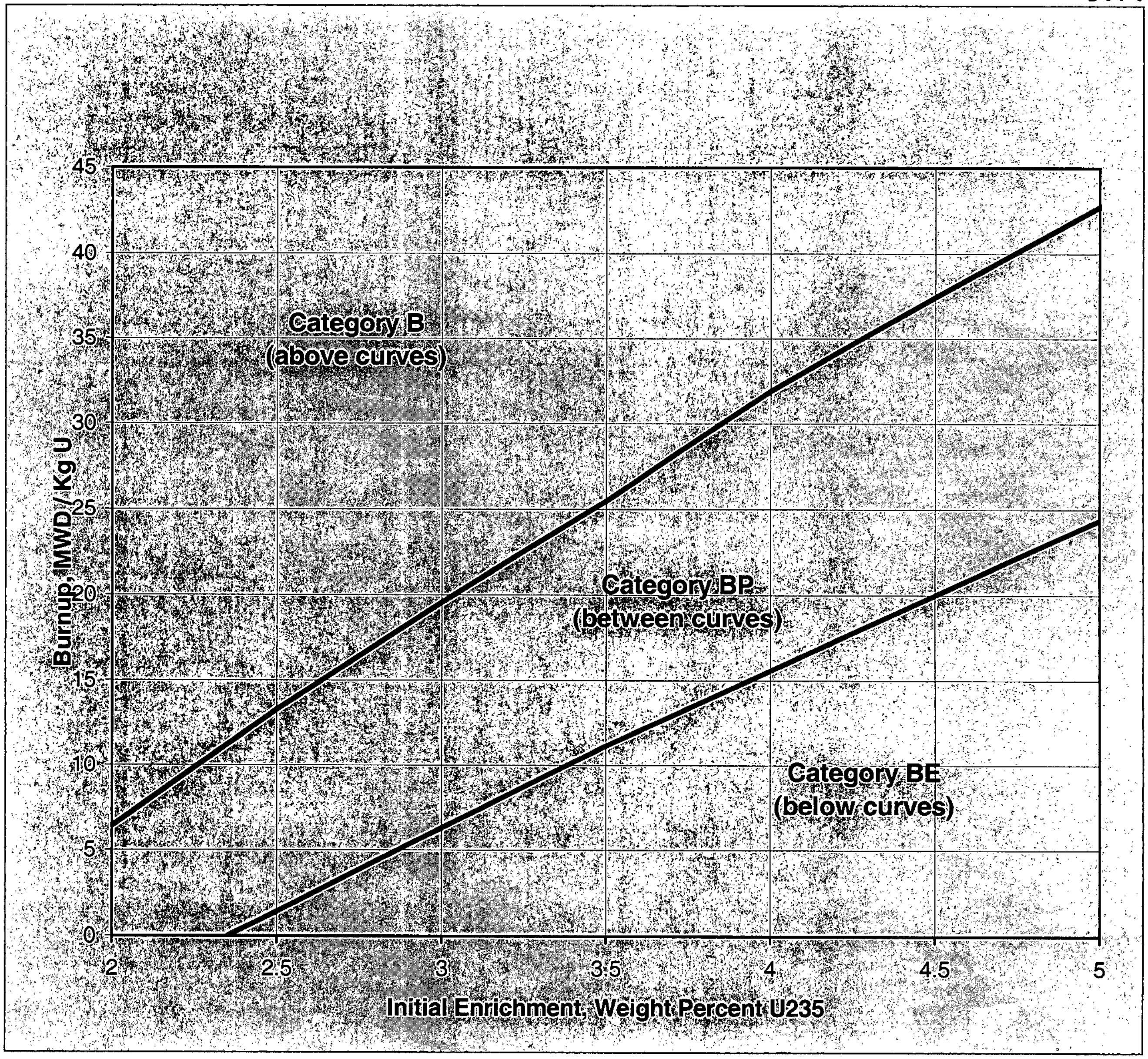


Figure 3.7.15-2
Burnup versus Enrichment Curve for
Spent Fuel Storage Pool B



1. Category B: Fuel from this category can be stored with no restrictions except as noted below.
2. Category BP: Fuel from this category (between lower and upper curves) can be stored in the peripheral cells of the pool.
3. Category BE: Unacceptable for storage unless surrounded by eight empty water cells. Fuel of any enrichment and burnup including fresh, unburned fuel may be stored in Pool B if surrounded by eight empty water cells. Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B.

Figure 3.7.15-2
Burnup versus Enrichment Curve for
Spent Fuel Storage Pool B

BASES

LCO (continued)

2. For new, low irradiation, and spent fuel with initial enrichment less than or equal to 5.0 weight percent and greater than or equal to 3.5 weight percent, fuel burnup must be within the limits specified in Figure 3.7.15-1. Figure 3.7.15-1 presents ~~two~~ three areas of required fuel assembly burnup as a function of initial enrichment.

a. Category B: ~~For f~~Fuel with enrichment-burnup combinations in the area above the upper curve~~,~~ can be stored with ~~there are~~ no restrictions ~~on where the fuel can be stored~~ except as noted below. That is, this fuel can be stored next to fuel with enrichment-burnups that fall into Categories A, B or F provided there are no restrictions on that fuel type preventing it. Category B has the same burnup-enrichment requirements for Pools A and B.

b. Category A: Fuel with enrichment-burnup between the curves can be stored in any configuration with fuel above the lower curve. That is, this fuel may be stored next to fuel with enrichment-burnups that fall into Categories A or B.

c. Category F: ~~For f~~Fuel with enrichment-burnup combinations below the lower curve~~, the fuel~~ must be stored in a one-out-of-two checkerboard configuration with fuel that has enrichment-burnup combinations above the upper curve (Category B) or with empty water cells that contain no fuel. Areas of Category F fuel stored in the checkerboard combination with Category B fuel or empty water cells must be separated from areas of Category A fuel by a transition row of Category B cells. The acceptability of storing this fuel in the checkerboard configuration is documented in References 6, 7, ~~and~~ 8 and 9.

Fuel enrichment limits are based on avoiding inadvertent criticality in the spent fuel pool. The CR-3 spent fuel storage system was initially designed to a maximum enrichment of 3.5 weight percent. Enrichments of up to 5.0 weight percent are permissible for storage in spent fuel pool A as long as the fuel burnup is sufficient to limit the worst case reactivity in the storage pool to less than or equal to 0.95. Fuel burnup reduces the reactivity of the fuel due to the accumulation of fission product poisons. Reference 1 documents that the required burnup varies linearly as a function of enrichment with 10500 megawatt days per metric ton uranium (Mwd/mtU) required for fuel with 5.0 weight percent enrichment and 0 burnup required for 3.5 weight percent enriched fuel.

Similar types of restrictions have been established for Pool B.

1. Initial fuel enrichment must be ≤ 5.0 weight percent U-235, and

2. For fuel with initial enrichment ≤ 5.0 weight percent and ≥ 2.0 weight percent, fuel burnup must be within the limits specified in Figure 3.7.15-2.

(continued)

BASES

LCO (continued)

a. Category B: Fuel with burnup-enrichment combinations in the area above the upper curve ~~has~~ can be stored with no restrictions ~~on where it can be stored~~ except as noted below. That is, this fuel can be stored next to fuel with burnup-enrichments that fall into Categories B or BP. Category B has the same burnup-enrichment requirements for Pools A and B.

b. Category BP: Fuel with burnup-enrichment combinations in the area between the lower and upper curves must be stored in the peripheral cells of the pool. ~~The~~ A peripheral cell~~s~~ ~~are those that are adjacent to the walls of the spent fuel pool.~~ is defined as the outermost of the first two storage cells closest to the spent fuel pool wall that has a fuel assembly located in it. If the storage cell closest to the spent fuel pool wall is kept empty of fuel, then the second storage cell from the spent fuel pool wall may be filled with lower burnup fuel meeting the requirements of Category BP fuel.

c. Category BE: Fuel of any burnup with an enrichment ≤ 5.0 weight percent, including fresh, unburned fuel, fuel from Category BP or fuel with burnup-enrichment combinations in the area below the lower curve can~~not~~ be ~~stored~~ placed in Pool B, but must be ~~stored in Pool A.~~ surrounded by eight empty water cells. Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B.

APPLICABILITY

In general, limiting fuel enrichment of stored fuel prevents inadvertent criticality in the storage pools. Inadvertent criticality is dependent on whether fuel is stored in the pools and is completely independent of plant MODE.

Therefore, this LCO is applicable whenever any fuel assembly is stored in high density fuel storage locations.

ACTIONS

A.1

Required Action A.1 is modified by a Note indicating LCO 3.0.3 does not apply. Since the design basis accident of concern in this Specification is an inadvertent criticality, and since the possibility or consequences of this event are independent of plant MODE, there is no reason to shutdown the plant if the LCO or Required Actions cannot be met.

When the configuration of fuel assemblies stored in the spent fuel pool is not in accordance with Figure 3.7.15-1 or Figure 3.7.15-2, immediate action must be taken to make the necessary fuel assembly movement(s) to bring the configuration into compliance. The Immediate Completion Time underscores the necessity of restoring spent fuel pool fuel loading to within the initial assumptions of the criticality analysis.

(continued)

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

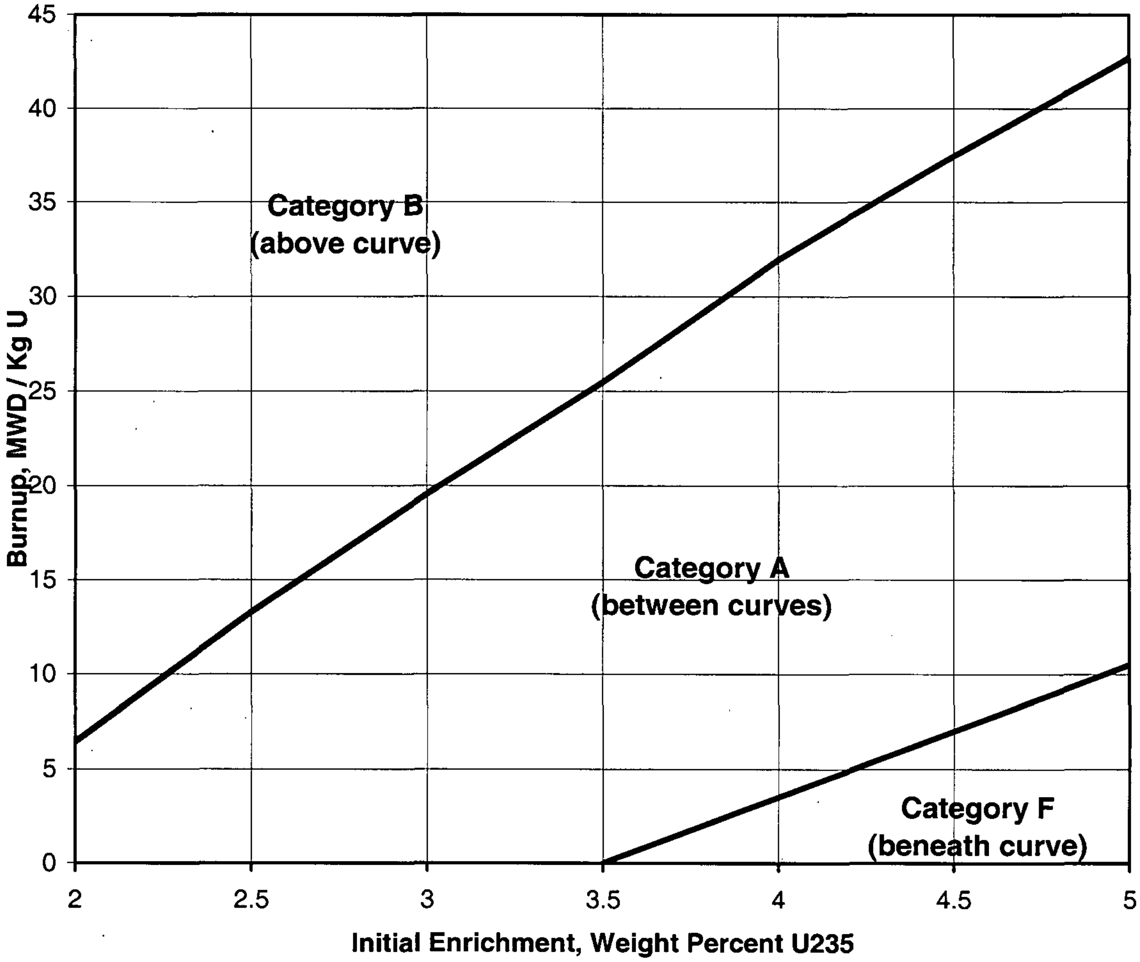
DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

LICENSE AMENDMENT REQUEST #292, REVISION 1

ADDITIONAL STORAGE PATTERNS FOR CRYSTAL RIVER UNIT 3 STORAGE POOLS A AND B

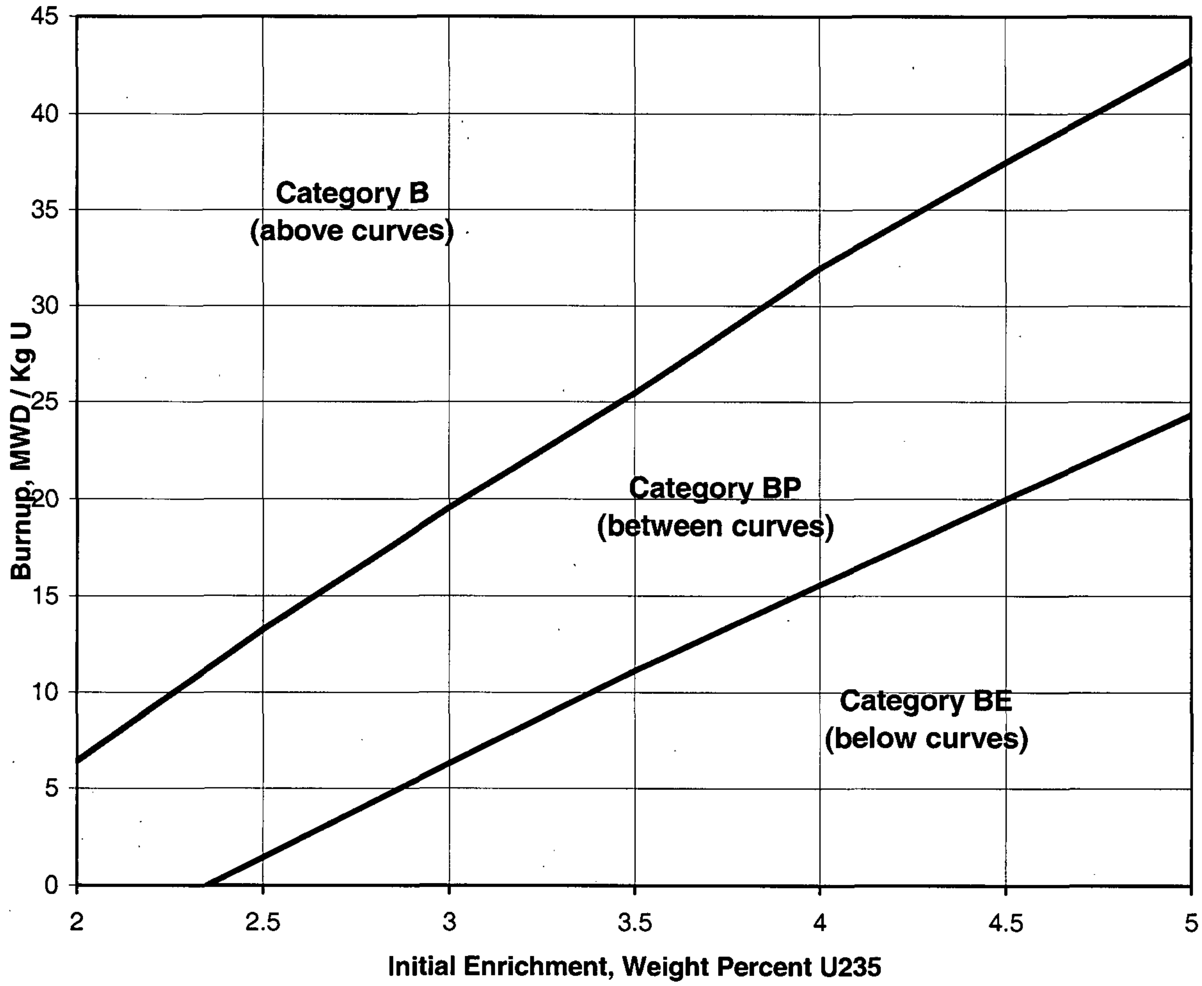
ATTACHMENT D

PROPOSED IMPROVED TECHNICAL SPECIFICATION AND BASES CHANGES (REVISION BAR FORMAT)



1. Category B: Fuel from this category can be stored with no restrictions except as noted below.
2. Category A: Fuel from this category can be stored with fuel from Categories A or B.
3. Category F: Fuel from this category must be stored in a one-out-of-two checkerboard configuration with fuel from Category B or empty water cells. Category F fuel stored in a checkerboard pattern with either Category B fuel or empty water cells must be separated from Category A fuel by a transition row of Category B fuel.

Figure 3.7.15-1
Burnup versus Enrichment Curve for
Spent Fuel Storage Pool A



1. Category B: Fuel from this category can be stored with no restrictions except as noted below.
2. Category BP: Fuel from this category (between lower and upper curves) can be stored in the peripheral cells of the pool.
3. Category BE: Unacceptable for storage unless surrounded by eight empty water cells.
4. Fuel of any enrichment and burnup including fresh, unburned fuel may be stored in Pool B if surrounded by eight empty water cells. Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B.

Figure 3.7.15-2
Burnup versus Enrichment Curve for
Spent Fuel Storage Pool B

BASES

SURVEILLANCE REQUIREMENTS

SR 3.7.14.1 (continued)

Operating experience has shown significant differences between boron measured near the top of the pool and that measured elsewhere. As long as this SR is met, the analyzed events are fully bounded. The 7 day Frequency is acceptable because no major replenishment of pool water is expected to take place over this period of time.

REFERENCES

1. Criticality Safety Evaluation of the Pool A Spent Fuel Storage Racks in Crystal River Unit 3 With Fuel of 5.0% Enrichment, S. E. Turner, Holtec Report HI-931111, December 1993.

2. Criticality Safety Analysis of the Westinghouse Spent Fuel Storage Racks in Pool B of Crystal River Unit 3, S. E. Turner, Holtec Report HI-992128, May 1999.

3. Criticality Safety Analysis of the Crystal River Unit 3 Pool A for Storage of 5% Enriched Mark B-11 Fuel in Checkerboard Arrangement with Water Holes, Holtec Report HI-992285, August 1999.

4. Criticality Evaluation of CR3 Spent Fuel Pool Storage Racks with Mark B-12 Fuel, Holtec Report HI-2022907, September 2002.

5. Progress Energy Engineering Change EC No. 52456, "Documentation of Acceptability to Receive and Store Mk-B/HTP Fuel".

6. Criticality Analysis of Additional Patterns for Crystal River 3 Pools A and B, Holtec Report HI-2063559, September 2006.

B 3.7 PLANT SYSTEMS

B 3.7.15 Spent Fuel Assembly Storage

BASES

BACKGROUND

This document describes the Bases for the Spent Fuel Assembly Storage which imposes storage requirements upon irradiated and unirradiated fuel assemblies stored in the fuel storage pools containing high density racks. The storage areas, which are part of the Spent Fuel System, governed by this Specification are:

a. Fuel storage pool "A" and
b. Fuel storage pool "B".

In general, the function of the storage racks is to support and protect new and spent fuel from the time it is placed in the storage area until it is shipped offsite.

Spent fuel is stored underwater in either fuel storage pool A or B. Only fuel pool A has the capability to store failed fuel in containers. Spent fuel pool A features high density poison storage racks with a 10 1/2 inch center-to-center distance capable of storing 542 assemblies. Fuel pool A is capable of storing fuel with enrichments up to 5.0 weight percent U-235 (Ref. 1, 6, 7, 8 and 9) without exceeding the criticality criteria of Reference 3 providing the fuel has sufficient burnup and required storage configuration.

Spent fuel pool B also contains high density racks having a 9.11 inch center-to-center distance capable of storing 932 assemblies. Fuel pool B is capable of storing fuel with enrichments up to 5.0 weight percent U-235 (Ref. 2, 7, 8 and 9) without exceeding the criticality criteria of Reference 3, providing the fuel has sufficient burnup and required storage configuration. New and low burnup fuel may be placed into pool B if surrounded by empty storage cells. This is primarily for, but not restricted to, fuel inspection and reconstitution activities (Ref. 9).

(continued)

BASES

BACKGROUND (continued)

Both of the spent fuel pools are constructed of reinforced concrete and lined with stainless steel plate. They are located in the fuel handling area of the auxiliary building.

New fuel storage requirements are addressed in Section 4.0, "Design Features".

APPLICABLE SAFETY ANALYSES

The function of the spent fuel storage racks is to support and protect spent fuel assemblies from the time they are placed in the pool until they are shipped offsite. The spent fuel assembly storage LCO was derived from the need to establish limiting conditions on fuel storage to assure sufficient safety margin exists to prevent inadvertent criticality. The spent fuel assemblies are stored entirely underwater in a configuration that has been shown to result in a reactivity of less than or equal to 0.95 under worse case conditions (Ref. 1, 2, 6, 7, 8 and 9). The spent fuel assembly enrichment requirements in this LCO are required to ensure inadvertent criticality does not occur in the spent fuel pool.

Inadvertent criticality within the fuel storage area could result in offsite radiation doses exceeding 10 CFR 50.67 limits.

The spent fuel assembly storage satisfies Criterion 2 of the NRC Policy Statement.

LCO

Limits on the new and irradiated fuel assembly storage in high density racks were established to ensure the assumptions of the criticality safety analysis of the spent fuel pools is maintained.

Limits on initial fuel enrichment and burnup for both new and for spent fuel stored in pool A have been established. Two limits are defined:

1. Initial fuel enrichment must be less than or equal to 5.0 weight percent U-235, and

(continued)

BASES

LCO (continued)

2. For new, low irradiation, and spent fuel with initial enrichment less than or equal to 5.0 weight percent and greater than or equal to 3.5 weight percent, fuel burnup must be within the limits specified in Figure 3.7.15-1. Figure 3.7.15-1 presents three areas of required fuel assembly burnup as a function of initial enrichment.

   a. Category B: Fuel with enrichment-burnup combinations in the area above the upper curve can be stored with no restrictions except as noted below. That is, this fuel can be stored next to fuel with enrichment-burnups that fall into Categories A, B or F provided there are no restrictions on that fuel type preventing it. Category B has the same burnup-enrichment requirements for Pools A and B.
   b. Category A: Fuel with enrichment-burnup between the curves can be stored in any configuration with fuel above the lower curve. That is, this fuel may be stored next to fuel with enrichment-burnups that fall into Categories A or B.
   c. Category F: Fuel with enrichment-burnup combinations below the lower curve must be stored in a one-out-of-two checkerboard configuration with fuel that has enrichment-burnup combinations above the upper curve (Category B) or with empty water cells that contain no fuel. Areas of Category F fuel stored in the checkerboard combination with Category B fuel or empty water cells must be separated from areas of Category A fuel by a transition row of Category B cells. The acceptability of storing this fuel in the checkerboard configuration is documented in References 6, 7, 8 and 9.

Fuel enrichment limits are based on avoiding inadvertent criticality in the spent fuel pool. The CR-3 spent fuel storage system was initially designed to a maximum enrichment of 3.5 weight percent. Enrichments of up to 5.0 weight percent are permissible for storage in spent fuel pool A as long as the fuel burnup is sufficient to limit the worst case reactivity in the storage pool to less than or equal to 0.95. Fuel burnup reduces the reactivity of the fuel due to the accumulation of fission product poisons. Reference 1 documents that the required burnup varies linearly as a function of enrichment with 10500 megawatt days per metric ton uranium (Mwd/mtU) required for fuel with 5.0 weight percent enrichment and 0 burnup required for 3.5 weight percent enriched fuel.

Similar types of restrictions have been established for Pool B.

1. Initial fuel enrichment must be ≤ 5.0 weight percent U-235, and

(continued)

BASES

LCO (continued)

2. For fuel with initial enrichment ≤ 5.0 weight percent and ≥ 2.0 weight percent, fuel burnup must be within the limits specified in Figure 3.7.15-2.

a. Category B: Fuel with burnup-enrichment combinations in the area above the upper curve can be stored with no restrictions except as noted below. That is, this fuel can be stored next to fuel with burnup-enrichments that fall into Categories B or BP. Category B has the same burnup-enrichment requirements for Pools A and B.
b. Category BP: Fuel with burnup-enrichment combinations in the area between the lower and upper curves must be stored in the peripheral cells of the pool. A peripheral cell is defined as the outermost of the first two storage cells closest to the spent fuel pool wall that has a fuel assembly located in it. If the storage cell closest to the spent fuel pool wall is kept empty of fuel, then the second storage cell from the spent fuel pool wall may be filled with lower burnup fuel meeting the requirements of Category BP fuel.
c. Category BE: Fuel of any burnup with an enrichment ≤ 5.0 weight percent, including fresh, unburned fuel, fuel from Category BP or fuel with burnup-enrichment combinations in the area below the lower curve can be placed in Pool B, but must be surrounded by eight empty water cells. Category BE fuel assemblies must be separated by two adjacent empty cells in Pool B.

APPLICABILITY

In general, limiting fuel enrichment of stored fuel prevents inadvertent criticality in the storage pools. Inadvertent criticality is dependent on whether fuel is stored in the pools and is completely independent of plant MODE.

Therefore, this LCO is applicable whenever any fuel assembly is stored in high density fuel storage locations.

ACTIONS

A.1

Required Action A.1 is modified by a Note indicating LCO 3.0.3 does not apply. Since the design basis accident of concern in this Specification is an inadvertent criticality, and since the possibility or consequences of this event are independent of plant MODE, there is no reason to shutdown the plant if the LCO or Required Actions cannot be met.

(continued)

BASES

ACTIONS

A.1 (continued)

When the configuration of fuel assemblies stored in the spent fuel pool is not in accordance with Figure 3.7.15-1 or Figure 3.7.15-2, immediate action must be taken to make the necessary fuel assembly movement(s) to bring the configuration into compliance. The Immediate Completion Time underscores the necessity of restoring spent fuel pool fuel loading to within the initial assumptions of the criticality analysis.

The ACTIONS do not specify a time limit for completing movement of the affected fuel assemblies to their correct location. This is not meant to allow an unnecessary delay in resolution, but is a reflection of the fact that the complexity of the corrective actions is unknown.

SURVEILLANCE REQUIREMENTS

SR 3.7.15.1

Verification by administrative means that initial enrichment and burnup of fuel assemblies in accordance with Figure 3.7.15-1 and Figure 3.7.15-2 is required prior to storage of spent fuel in storage pool A or pool B (as applicable). This surveillance ensures that fuel enrichment limits, as specified in the criticality safety analyses (Ref. 1, 2, 6, 7 and 8), are not exceeded. The surveillance Frequency (prior to storage in high density region of the fuel storage pool) is appropriate since the initial fuel enrichment and burnup cannot change after removal from the core.

REFERENCES

1. Criticality Safety Evaluation of the Pool A Spent Fuel Storage Racks in Crystal River Unit 3 with Fuel of 5.0% Enrichment, S. E. Turner, Holtec Report HI 931111, December 1993.
2. Criticality Safety Analysis of the Westinghouse Spent Fuel Storage Racks in Pool B of Crystal River Unit 3, S. E. Turner, Holtec Report HI-992128, May 1999.
3. NUREG 0800, Standard Review Plan, Section 9.1.1 and 9.1.2, Rev. 2, July 1981.
4. 10 CFR 50.67.
5. CR-3 FSAR, Section 9.6.
6. Criticality Safety Analysis of the Crystal River Unit 3 Pool A for Storage of 5% Enriched Mark B-11 Fuel in Checkerboard Arrangement With Water Holes, S. E. Turner, Holtec Report HI-992285, August 1999.

(continued)

BASES

REFERENCES (continued)

7. Criticality Evaluation of CR3 Spent Fuel Pool Storage Racks with Mark B-12 Fuel, Holtec Report HI-2022907, September 2002.

8. Progress Energy Engineering Change EC No. 52456, "Documentation of Acceptability to Receive and Store Mk-B/HTP Fuel".

9. Criticality Analysis of Additional Patterns for Crystal River 3 Pools A & B for Progress Energy, Holtec Report No. HI-2063579, September 2006.

PROGRESS ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

LICENSE AMENDMENT REQUEST #292, REVISION 1

ADDITIONAL STORAGE PATTERNS FOR CRYSTAL RIVER UNIT 3 STORAGE POOLS A AND B

ATTACHMENT F

HOLTEC INTERNATIONAL AFFIDAVIT FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

HOLTEC
INTERNATIONAL

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

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk

AFFIDAVIT PURSUANT TO 10 CFR 2.390

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

(1) I am the Holtec International Project Manager for the Crystal River Criticality Analysis Project (Holtec Project 1250) and have reviewed the information described in paragraph (2) which is sought to be withheld, and am authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Revision 1 of Holtec Report HI-2022907.

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

HOLTEC INTERNATIONAL

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

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk

AFFIDAVIT PURSUANT TO 10 CFR 2.390

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

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

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

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

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

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

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

(5) The information sought to be withheld is being submitted to the NRC in confidence. The information (including that compiled from many sources) is of a sort customarily held in confidence by Holtec International, and is in fact so

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

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk

AFFIDAVIT PURSUANT TO 10 CFR 2.390

held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by Holtec International. No public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

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

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

(8) The information classified as proprietary was developed and compiled by Holtec International at a significant cost to Holtec International. This information is classified as proprietary because it contains detailed descriptions of analytical approaches and methodologies not available elsewhere. This information would provide other parties, including competitors, with information from Holtec

HOLTEC INTERNATIONAL

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

International's technical database and the results of evaluations performed by Holtec International. A substantial effort has been expended by Holtec International to develop this information. Release of this information would improve a competitor's position because it would enable Holtec's competitor to copy our technology and offer it for sale in competition with our company, causing us financial injury.

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

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

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

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

The value of this information to Holtec International would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar

HOLTEC INTERNATIONAL

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

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk

AFFIDAVIT PURSUANT TO 10 CFR 2.390

expenditure of resources would unfairly provide competitors with a windfall, and deprive Holtec International of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

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

Dr. Debabrata Mitra-Majumdar, being duly sworn, deposes and says:

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

Executed at Marlton, New Jersey, this 3rd day of July, 2007.

Debabrata Mitra-Majumdar
Holtec International

Subscribed and sworn before me this 3rd day of July, 2007.

Maria C. Massi

MARIA C. MASSI
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires April 25, 2010