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L-2011-032
10 CFR 50.90
10 CFR 2.390

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

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
License Amendment Request No. 207
Supplement 1 to Fuel Storage Criticality Analysis

References:

(1) Brenda L. Mozafari (NRC) to J. A. Stall (FPL), "Issuance of Amendments Regarding Spent Fuel Pool Boraflex Remedy (TAC Nos. MC9740 and MC9741)," July 17, 2007

(2) M. Kiley (FPL) to U. S. Nuclear Regulatory Commission (L-2010-169), "License Amendment Request No. 207 Fuel Storage Criticality Analysis," Accession No. ML102220022, August 5, 2010

(3) DSS-ISG-2010-01, Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools

In accordance with the provisions of 10 CFR 50.90, Florida Power and Light Company (FPL) requests that Appendix A of Renewed Facility Operating Licenses DPR-31 and DPR-41 for Turkey Point Units 3 and 4 be amended to incorporate the enclosed Technical Specification (TS) revisions. The proposed amendments would revise TS 5.5.1 Fuel Storage – Criticality, to include new spent fuel storage patterns that account for both the increase in fuel maximum enrichment from 4.5 wt% U-235 to 5.0 wt% U-235 and the impact on the fuel of higher power operation proposed under the Extended Power Uprate (EPU) project. Although the fuel storage has been analyzed at the higher fuel enrichment in the new criticality analysis, the fuel enrichment limit of 4.5 wt% U-235 specified in TS 5.5.1 will not be changed under this license amendment request.

The proposed TS changes and the supporting criticality analysis are being submitted to revise the current licensing basis analysis for both new fuel and spent fuel pool storage. This submittal supplements LAR No. 207 Fuel Storage Criticality Analysis, dated August 5, 2010 [Reference 2] but is provided here as a stand alone document, i.e., it revises, in its entirety (both content and form) the previous submittal. The proposed TS changes do not revise spent fuel pool capacity limits. A separate license amendment request will be submitted by May 30, 2011 to revise TS 5.5.3 per FPL's commitment in Licensee Event Report 05000250 / 2010-001-01 dated November 22, 2010. The planned change to TS 5.5.3 results from the removal from service of sixteen storage cells in each spent fuel pool that have been damaged by cooling system flow.

The Spent Fuel Pool Boraflex Remedy approved under Amendments 234 and 229 for Units 3 and 4, respectively, and described in Reference 1, is currently implemented for both units. On August 5, 2010, FPL submitted License Amendment Request No. 207 (Reference 2) with a new criticality analysis detailed in WCAP-17094-P, Rev 2, "Turkey Point Units 3 and 4 New Fuel Storage Rack and Spent Fuel Pool Criticality Analysis," dated July 2010. On September 27, 2010, the U. S.

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Nuclear Regulatory Commission (NRC) issued the draft Interim Staff Guidance (ISG) DSS-ISG-2010-1 (Reference 3) for public comment. WCAP-17094-P was revised to address this interim staff guidance. The TS changes proposed here are based on the results of the revised criticality analysis provided in Attachment 4, WCAP-17094-P, Rev 3, "Turkey Point Units 3 and 4 New Fuel Storage Rack and Spent Fuel Pool Criticality Analysis," dated February 2011, that was performed, in part, to support the proposed EPU for Turkey Point Units 3 and 4.

The Enclosure to this letter contains a description of the proposed changes and their supporting justifications including a no significant hazards determination and environmental considerations.

The Attachments to the Enclosure are as follows:

- Attachment 1 contains the approved Amendment 234 and 229 TS pages marked-up to show the proposed changes.
- Attachment 2 contains the non-proprietary version of the Westinghouse Topical Report, WCAP-17094-NP, Rev 3, Turkey Point Units 3 and 4 New Fuel Storage Rack and Spent Fuel Pool Criticality Analysis, dated February 2011.
- Attachment 3 contains the application for withholding the proprietary information contained in the WCAP-17094-P, Rev 3, Attachment 4, from public disclosure.
- Attachment 4 contains the proprietary version of the Westinghouse Topical Report, WCAP-17094-P, Rev 3, Turkey Point Units 3 and 4 New Fuel Storage Rack and Spent Fuel Pool Criticality Analysis, dated February 2011.

As Attachment 4 contains information proprietary to Westinghouse Electric Company, LLC (Westinghouse), it is supported by the Attachment 3 affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis for which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b) (4) of § 2.390 of the Commission's' regulations. Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR 2.390 of the Commission's regulations.

Correspondence with respect to the copyright or proprietary aspects of the items provided in Attachment 4 of this letter in WCAP-17094-P, Rev 3 or the supporting Westinghouse affidavit should reference CAW-11-3100 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, Suite 428, 1000 Westinghouse Drive, Cranberry Township, PA 16066.

The Turkey Point Plant Nuclear Safety Committee (PNSC) has reviewed the proposed license amendments. In accordance with 10 CFR 50.91(b)(1), a copy of this letter is being forwarded to the State Designee of Florida.

The proposed TS changes have been evaluated in accordance with 10 CFR 50.91(a)(1), using the criteria in 10 CFR 50.92(c). FPL has determined that the proposed TS changes do not involve a significant hazards consideration.

The proposed license amendments change requirements with respect to the use of a facility component located within the restricted area as defined in 10 CFR Part 20. FPL has determined that the proposed amendments involve no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite, and no significant increase in individual or cumulative occupational radiation exposure.

Therefore, FPL has concluded that the proposed amendments meet the criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9) and, pursuant to 10 CFR 51.22(b), an environmental impact statement or environmental assessment need not be prepared in connection with issuance of the amendments.

This letter contains no new commitments and no revisions to existing commitments.

It is requested that issuance of this requested amendment be no later than December 31, 2011 prior to the Unit 3 Spring and Unit 4 Fall 2012 outages.

Should you have any questions regarding this submittal, please contact Mr. Robert J. Tomonto, Licensing Manager, at (305) 246-7327.

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

Executed on February 22, 2011.

Very truly yours,

Michael Kiley
Site Vice President
Turkey Point Nuclear Plant

Enclosure

cc: USNRC Regional Administrator, Region II
USNRC Project Manager, Turkey Point Nuclear Plant
USNRC Senior Resident Inspector, Turkey Point Nuclear Plant
Mr. W. A. Passetti, Florida Department of Health (w/o Attachment 4)

Turkey Point Units 3 and 4

LAR NO. 207
"FUEL STORAGE CRITICALITY ANALYSIS" - SUPPLEMENT 1

ENCLOSURE

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LICENSE AMENDMENT REQUEST

FUEL STORAGE CRITICALITY ANALYSIS

1.0 Purpose and Scope

The following information is provided by Florida Power & Light (FPL) to supplement License Amendment Request (LAR) No. 207, Fuel Storage Criticality Analysis for Turkey Point Nuclear Plant (PTN) Units 3 and 4 that was submitted to the NRC by FPL letter L-2010-169 dated August 5, 2010 [Reference 1]. This supplement addresses issues raised in the U. S. Nuclear Regulatory Commission's (NRC) draft Interim Staff Guidance (ISG) DSS-ISG-2010-01 regarding Nuclear Criticality Analysis for Spent Fuel Pools [Reference 2].

FPL proposes to revise the Turkey Point (PTN) Units 3 and 4 licensing basis for spent fuel pools by amending Appendix A of Renewed Facility Operating Licenses DPR-31 and DPR-41 for Turkey Point Units 3 and 4 to incorporate the enclosed Technical Specification (TS) revisions. The proposed TS changes and a new supporting criticality analysis are being submitted here to revise the current licensing basis analysis for both new fuel and spent fuel pool storage.

The proposed amendments will revise TS 5.5.1 Fuel Storage – Criticality, to include new spent fuel pool storage patterns that account for both the increase in fuel maximum enrichment from 4.5 wt% U-235 to 5.0 wt% U-235 and the impact on the fuel of the higher power operation proposed under the Extended Power Uprate (EPU) project. Although the fuel storage has been analyzed at the higher fuel enrichment in the new criticality analysis, the fuel enrichment limit of 4.5 wt% U-235 specified in TS 5.5.1 will not be changed under this license amendment request. The licensing basis for the spent fuel pools will reflect the new criticality analysis performed by Westinghouse, WCAP-17094-P, Rev 3, "Turkey Point Units 3 and 4 New Fuel Storage Rack and Spent Fuel Pool Criticality Analysis," dated February 2011 which addresses the recently issued NRC Draft Interim Staff Guidance DSS-ISG-2010-01, Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools.

2.0 Background Information

As described in Section 9.5.2 of the Updated Final Safety Analysis Report (UFSAR), spent fuel storage is provided by a spent fuel pool for each unit located at opposite ends of the Auxiliary Building. Each spent fuel pool is designed for underwater storage of no more than 1519 fuel assemblies (approximately 9 full cores) and miscellaneous fuel handling tools. The spent fuel pool is designed to store both fresh and burned fuel. The spent fuel pool uses a Distinct Zone Two Region rack design. The Region I racks can accommodate 286 fuel assemblies and the Region II racks can store no more than 1102 fuel assemblies. In addition, a removable cask area rack can store 131 fuel assemblies with a maximum fuel enrichment of 4.5 wt% U-235. Criticality of fuel assemblies in the fuel storage racks is prevented by the design of the racks which limits fuel assembly interaction. This is done by fixing the minimum separation between fuel assemblies and/or placing absorber panels between storage cells. The spent fuel storage racks are free-standing, seismically qualified components composed of individual storage cells made of stainless steel that are wrapped with a neutron absorbing material.

The spent fuel storage racks are designed to maintain subcritical conditions with a k_{eff} of less than 1.0 with unborated water in the spent fuel pit or with a k_{eff} of less than or equal to 0.95 with a specified level of soluble boron. The process of fuel handling and storage in the spent fuel pool is controlled administratively by procedure. However, as the possibility of spent fuel mislocation or misorientation exists, criticality analyses have been conducted for the most limiting cases to assure that any consequences are accommodated by the design.

Although the two region storage racks have been analyzed for the storage of 1404 fuel assemblies, current storage capacity is administratively limited to 1388 fuel assemblies as a result of the removal from service of 16 cells damaged by cooling system flow.

License Amendment Request No. 178, Spent Fuel Pool Boraflex Remedy, was submitted to the NRC on January 27, 2006 in order to eliminate the need to credit Boraflex™ neutron absorbing material for reactivity control in the spent fuel pools through use of analyzed new spent fuel storage patterns and Metamic™ rack inserts [Reference 3]. The Metamic™ inserts are manufactured in the shape of an "L" and, when inserted, blanket two of the four walls of the host storage cell. Metamic™ neutron absorber material is a metal matrix composite consisting of a matrix of 6061 aluminum alloy reinforced with Type 1 ASTM C-750 boron carbide. The Metamic™ inserts are installed into selected spent fuel pit rack cells and establish allowed spent fuel storage configurations based on assembly initial enrichment, burnup and post-irradiation cooling times. License Amendments 234 and 229 were issued by the NRC on July 17, 2007 and affect TS Section 3/4 9.1, "Boron Concentration," Section 3/4 9.14, "Spent Fuel Storage," and Section 5.5.1, "Fuel Storage Criticality" [Reference 4]. The reactivity control function originally credited to the Boraflex™ neutron absorbers, in the Unit 3 and 4 spent fuel pool storage racks, is now performed by a combination of rod cluster control assemblies (RCCAs), Metamic™ rack inserts, open water holes, and administrative controls that require mixing higher reactivity fuel with lower-reactivity fuel. The implementation of the Boraflex Remedy was completed in late 2010 for both units.

3.0 Description of Proposed Changes

The proposed TS changes are based on the attached Westinghouse Spent Fuel Pool Criticality Analysis that was completed to support the proposed EPU for Turkey Point Units 3 and 4. See Attachment 4, WCAP-17094-P, Rev 3, Turkey Point Units 3 and 4 New Fuel Storage Rack and Spent Fuel Pool Criticality Analysis, dated February 2011. The analysis accounts for an increase in the fuel maximum enrichment from 4.5 wt% U-235 to 5.0 wt% U-235 and the impact on the fuel of higher power operation at EPU conditions, e.g., the depletion of fuel at higher EPU conditions that results in the fuel being more reactive at the same burnup than the fuel depleted under current operating conditions, that are proposed under the EPU project. Although the fuel storage has been analyzed at the higher fuel enrichment in the new criticality analysis, the fuel enrichment limit of 4.5 wt% U-235 specified in TS 5.5.1 will not be changed under this license amendment request. As stated above, the Spent Fuel Pool Boraflex Remedy has been implemented and is assumed in this analysis. The analysis is performed consistent with the guidance in NRC draft Interim Staff Guidance DSS-ISG-2010-01. The proposed TS changes and new supporting criticality analysis are being submitted here to completely revise the current licensing basis analysis for both new fuel and spent fuel pool storage.

As indicated in Section 2.0 above, each unit's Spent Fuel Pool consists of the permanent Region I and Region II racks and the removable cask area rack. The existing Region I and II racks have been evaluated for the placement of fuel with new allowable storage configurations. Consistent with the storage patterns in License Amendment No. 234 (Unit 3) and No. 229 (Unit 4), the evaluation credits neutron absorber inserts placed into the Region II racks to partially offset an assumed full loss of the Boraflex. In the analysis, credit is taken for the negative reactivity associated with burnup and post-irradiation cooling time. Additionally, credit is taken for the presence of soluble boron in the spent fuel pool and for the presence of full-length RCCAs placed in selected fuel assemblies. The presence of Integrated Fuel Burnable Absorber (IFBA) rods is also credited for certain fresh fuel evaluations. The analysis considered fuel placement under both normal and all postulated accident conditions. Accident conditions considered in the analysis included misloaded fresh fuel assembly into incorrect storage rack location, inadvertent removal of an absorber insert, spent fuel pool temperature greater than normal operating range (150°F), loss of water gap between Region I and Region II due to a seismic event, dropped fresh fuel assembly, and misplaced fuel assembly.

The following changes to the current licensing basis, i.e., differences between the Spent Fuel Pool Boraflex Remedy Analysis and WCAP-17094-P, are provided here:

- Assumes storage of fuel assemblies with a maximum enrichment of 5.0 wt % U-235
- Assumes fuel burnup under EPU operating conditions (2644 MWt)
- Addresses technical guidance provided in Section IV of the NRC draft Interim Staff Guidance DSS-ISG-2010-01 including topics raised in the following analysis aspects:
  - Fuel Assembly Selection
  - Depletion Analysis
    - Depletion Uncertainty
    - Reactor Parameters
    - Burnable Parameters
    - Hafnium Flux Suppressor Inserts
    - Rodded Operations
  - Criticality Analysis
    - Axial Burnup Profile
    - Rack Model Description
    - Rack Materials and Dimensions
    - Neutron Absorber Efficiency
    - Interface Analysis
    - Normal Conditions
    - Accident Conditions
  - Criticality Code Validation
    - Area of Applicability
    - HTC Critical Experiments
    - Trend Analysis
    - Statistical Treatment

- o Lumped Fission Products

Accordingly, the following is a summary of the changes that are proposed to the PTN TS. Justification for these proposed changes is provided in Section 4.2. See Attachment 1 for marked-up TS pages of these changes.

5.5.1.1 Design Features – (Spent) Fuel Storage – Criticality. The minimum boron concentration in the spent fuel pool required to maintain k_{eff} for all permissible fuel storage arrangements less than or equal to 0.95 under normal conditions is reduced from 650 ppm to 500 ppm.

5.5.1.3 Design Features – (Spent) Fuel Storage – Criticality. Storage requirements are defined for EPU fuel that consider the higher allowable fuel assembly enrichment and the higher reactivity of the fuel operated at EPU conditions.

Table 5.5-1 Tables completely revised and reduced to one page.

Table 5.5-2 Tables completely revised and reduced to one page.

Table 5.5-3 Table completely revised.

Table 5.5-4 New Table for IFBA Requirements for Fuel Category I-2

Figure 5.5-1 Figure completely revised.

Figure 5.5-2 Figure completely revised.

Figure 5.5-3 Figure completely revised.

Figure 5.5-4 Figure deleted.

To provide more specific description of the proposed changes, TS mark-ups are provided in Attachment 1. An item-by-item description is provided below along with a brief justification for each change.

4.0 Basis/Justification for the Proposed Changes

4.1 Methodology/Assumption Changes Between Boraflex Remedy and WCAP Analyses

The new WCAP-17094-P criticality analysis was conducted to support the proposed EPU which has two major impacts on the criticality analysis: (1) The fuel maximum enrichment will be increased from 4.5 wt% U-235 to 5.0 wt% U-235 and (2) the depletion of fuel at the EPU conditions results in the fuel being more reactive at the same burnup than fuel depleted under current conditions. This is due to the higher fuel and moderator temperatures that result in a harder neutron spectrum, resulting in more plutonium production. The analysis also addresses regulatory issues identified in the recently issued NRC Draft Interim Staff Guidance DSS-ISG-2010-01, Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools.

4.2 Changes to the PTN Operating Licenses and Technical Specifications

4.2.1 Technical Specification 5.5.1 Fuel Storage - Criticality

Approved TS

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

b. A k_{eff} less than or equal to 0.95 when flooded with water borated to 650 ppm, which includes an allowance for biases and uncertainties as described in UFSAR Chapter 9.

c. A nominal 10.6 inch center-to-center distance for Region I and 9.0 inch center-to-center distance for Region II for the two region spent fuel pool storage racks. A nominal 10.1 inch center-to-center distance in the east-west direction and a nominal 10.7 inch center-to-center distance in the north-south direction for the Region I cask area storage rack.

f. Fresh or irradiated fuel assemblies not stored in the cask area storage rack shall be stored in accordance with Specification 5.5.1.3 or configurations that have been shown to comply with Specification 5.5.1.1a and 5.5.1.1b using the NRC approved methodology in UFSAR Chapter 9.

Proposed TS

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

b. A k_{eff} less than or equal to 0.95 when flooded with water borated to 500 ppm, which includes an allowance for biases and uncertainties as described in UFSAR Chapter 9.

c. A nominal 10.6 inch center-to-center distance for Region I and 9.0 inch center-to-center distance for Region II for the two region spent fuel pool storage racks. A nominal 10.1 inch center-to-center distance in the east-west direction and a nominal 10.7 inch center-to-center distance in the north-south direction for the cask area storage rack.

f. Fresh or irradiated fuel assemblies not stored in the cask area storage rack shall be stored in accordance with Specification 5.5.1.3 or configurations that have been shown to comply with Specification 5.5.1.1a and 5.5.1.1b using NRC approved methodology in UFSAR Chapter 9.

Basis for the Change: Technical Specification 5.5.1.1.b is updated to reflect analyses showing that k_{eff} for all permissible fuel storage arrangements is less than or equal to 0.95 under normal and accident conditions when the storage racks are assumed to be flooded with borated water of a minimum boron concentration of 500 ppm. Technical Specification 5.5.1.1.c is modified to remove the characterization of the cask area storage rack as a Region I rack. Analyses demonstrate that the interface requirements between Region I and Region II are not applicable to the cask area storage rack.

4.2.2 Technical Specification 5.5.1 Fuel Storage – Criticality (continued)

Approved TS

5.5.1.3 Credit for burnup and cooling time is taken in determining acceptable placement locations for spent fuel in the two-region spent fuel racks. Fresh or irradiated fuel assemblies shall be stored in compliance with the following:

a. Any 2x2 array of Region I storage cells containing fuel shall comply with the storage patterns in Figure 5.5-1 and the requirements of Table 5.5-1 and 5.5-2, as applicable. The reactivity rank of fuel assemblies in the 2x2 array (rank determined using Table 5.5-3) shall be equal to or less than that shown for the 2x2 array.

b. Any 2x2 array of Region II storage cells containing fuel shall:

    i. Comply with the storage patterns in Figure 5.5-2 and the requirements of Table 5.5-1 and 5.5-2, as applicable. The reactivity rank of fuel assemblies in the 2x2 array (rank determined using Table 5.5-3) shall be equal to or less than that shown for the 2x2 array.

    ii. Have the same directional orientation for Metamic inserts in a contiguous group of 2x2 arrays where Metamic inserts are required,

    iii. Comply with the requirements of 5.5.1.3.c for cells adjacent to Region I racks, and

    iv. Comply with the requirements of 5.5.1.3.d for cells adjacent to the spent fuel pit walls.

c. Any 2x2 array of Region II storage cells that interface with Region I shall comply with the rules of Figure 5.5-3. Arrays II-E and II-F may interface with Region I without special restriction.

d. Any 2x2 array of Region II storage cells may adjoin a row of assemblies with a reactivity rank of II-2 (or lower) that is located in the outer row adjacent to the spent fuel pit wall. The outer row of reactivity rank II-2 (or lower) fuel assemblies need not contain any Metamic inserts or full length RCCAs, as long as the following additional requirements are met:

    i. Fuel is loaded to comply with the allowable storage patterns defined in Figure 5.5-4, and ii Arrays II-E and II-F are loaded without any additional restriction on that 2x2 array. Arrays II-E and II-F do not have empty cells, Metamic inserts, or RCCAs that restrict the interface with the adjoining reactivity rank II-2 (or lower) fuel assemblies.

Proposed TS

5.5.1.3 Credit for burnup and cooling time is taken in determining acceptable placement locations for spent fuel in the two-region spent fuel racks. Unless otherwise specified in accordance with Specification 5.5.1.1.f, fresh or irradiated fuel assemblies shall be stored in compliance with the following:

a. Any 2x2 array of Region I storage cells containing fuel shall comply with the storage patterns in Figure 5.5-1 and the requirements of Tables 5.5-1 and 5.5-2, as applicable. The reactivity rank of fuel assemblies in the 2x2 array (rank determined using Table 5.5-3) shall be equal to or less reactive than that shown for the 2x2 array.

b. Any 2x2 array of Region II storage cells containing fuel shall:

   i. Comply with the storage patterns in Figure 5.5-2 and the requirements of Tables 5.5-1 and 5.5-2, as applicable. The reactivity rank of fuel assemblies in the 2x2 array (rank determined using Table 5.5-3) shall be equal to or less reactive than that shown for the 2x2 array,

   ii. Have the same directional orientation for Metamic inserts in a contiguous group of 2x2 arrays where Metamic inserts are required, and

   iii. Comply with the requirements of 5.5.1.3.c for cells adjacent to Region I racks.

c. Any 2x2 array of Region II storage cells that interface with Region I storage cells shall comply with the rules of Figure 5.5-3.

d. Any fuel assembly may be replaced with a fuel rod storage basket or non-fuel hardware.

e. Storage of Metamic inserts or RCCAs is acceptable in locations designated as empty (water-filled) cells.

Table 5.5-1 Tables completely revised and reduced to one page.

Table 5.5-2 Tables completely revised and reduced to one page.

Table 5.5-3 Table completely revised.

Table 5.5-4 New Table for IFBA Requirements for Fuel Category I-2

Figure 5.5-1 Figure completely revised.

Figure 5.5-2 Figure completely revised.

Figure 5.5-3 Figure completely revised.

Figure 5.5-4 Figure deleted.

Basis for the Change: Technical Specification 5.5.1.3 is updated to reflect the new analysis results that revise the fuel categories and configurations. Technical Specifications 5.5.1.3.b.iv and 5.5.1.3.d are deleted as the new analysis does not contain specific requirements for cells adjacent to the spent fuel pit walls. Technical Specifications 5.5.1.3.c is updated to remove the statement with regards to configurations that are not part of the new analysis. A new Technical Specifications 5.5.1.3.d is added to specify the handling of fuel rod storage baskets or non-fuel hardware, as well as the acceptability of storing Metamic inserts or RCCAs in locations designated as empty cells. Note: A debris/trash storage basket may not be stored in a cell that is required to be empty by the criticality analysis (e.g. empty cells in configurations I-A and II-A). Technical Specifications Tables 5.5-1, 5.5-2 and 5.5-3, as well as Figures 5.5-1, 5.5-2 and 5.5-3 are replaced with the new analysis results that revise the fuel categories and configurations. Technical Specifications Table 5.5-4 is added to specify burnable absorber (IFBA) requirements for fuel category I-2. Technical Specifications Figure 5.5-4 is deleted as the new analysis does not contain specific requirements for cells adjacent to the spent fuel pit walls.

4.3 Disposition of Recent SFP Submittals RAIs

A review of NRC Requests for Additional Information (RAIs) received concerning the recent SFP submittals was performed. The subjects of the RAIs that could be applicable to PTN Units 3 & 4 have been reviewed and incorporated in this LAR, as appropriate.

5.0 List of Commitments

None

6.0 Conclusion

The criticality analysis evaluated the different 2x2 storage arrays that are designed to accommodate both fresh fuel and spent discharged fuel. The analysis confirmed the acceptability of each storage array in the spent fuel pool and the appropriate limitations to be placed on the use of each array noting that fuel of lower reactivity, i.e., greater burnup, than the maximum allowable may be placed in an array. The analysis demonstrated that the effective neutron multiplication factor (k_{eff}) of all permissible fuel storage arrangements is less than 0.95 when the storage racks are assumed to be flooded with borated water. The analysis also demonstrated that the k_{eff} is less than 0.95 under all postulated accident conditions. Finally, the analysis demonstrated that the k_{eff} of each fuel storage arrangement remains less than 1.0 when the pool is assumed to be flooded with unborated water.

Although allowable fuel enrichment remains unchanged by this submittal, the analysis shows that fresh fuel of up to 5.0 wt% U-235 could be stored in the cask area rack under fully flooded conditions and meet the applicable acceptance criteria. The analysis also demonstrated that a fuel rod basket can be placed in any fuel storage cell and in any region without restrictions.

7.0 No Significant Hazards Determination

The Commission has provided standards in 10 CFR 50.92(c) for determining whether a significant hazards consideration exists. A proposed amendment to an operating license for a facility involves no significant hazard if operation of the facility in accordance with the proposed amendment would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety.

The proposed license amendments to Renewed Facility Operating Licenses DPR-31 for Turkey Point Unit 3 and DPR-41 for Turkey Point Unit 4 will revise the Technical Specifications to eliminate the current spent fuel pool storage patterns and replace them with new spent fuel pool storage patterns. The new patterns use a combination of rod control cluster assemblies, borated aluminum (Metamic) rack inserts, and administrative controls that require dispersing higher reactivity fuel to achieve acceptable neutron multiplication. The supporting WCAP criticality analysis addresses the safe storage of new and spent fuel with a maximum fuel enrichment of up to 5.0 wt% U-235. The radiological dose consequences associated with fuel enrichment at this level have been addressed in LAR 196 on Alternative Source Term implementation at EPU conditions (Reference 5). However, the maximum fuel enrichment for both new and spent fuel storage currently allowed by Technical Specifications will not be changed by this LAR.

The introduction of Metamic rack inserts into the spent fuel pool and the increased fuel handling that are required to achieve new fuel storage configurations using these inserts were previously addressed in the Boraflex Remedy LAR (Reference 3). The design and operational considerations upon which the previous evaluation was based are reiterated below and the conclusions have not changed as a result of the proposed amendment.

FPL has reviewed this proposed license amendment for FPL's Turkey Point Units 3 and 4 and determined that its adoption would not involve a significant hazards consideration. The bases for this determination are:

The proposed amendment does not involve a significant hazards consideration for the following reasons:

1. **Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?**

   No. The proposed amendments do not change or modify the fuel, fuel handling processes, fuel storage racks, number of fuel assemblies that may be stored in the spent fuel pool (SFP), decay heat generation rate, or the spent fuel pool cooling and cleanup system. The proposed amendment was evaluated for impact on the following previously evaluated events and accidents:

a. A fuel handling accident (FHA),
b. A cask drop accident,
c. A fuel mispositioning or inadvertent insert removal event,
d. A spent fuel pool boron dilution event,
e. A seismic event, and
f. A loss of spent fuel pool cooling event

Although the proposed amendment will required increased handling of the fuel, the probability of a FHA is not significantly increased because the implementation of the proposed amendment will employ the same equipment and process to handle fuel assemblies that is currently used. Also, tests have confirmed that the Metamic inserts can be installed and removed without damaging the host fuel assemblies. The FHA radiological dose consequences associated with fuel enrichment at this level were addressed in LAR 196 on Alternative Source Term implementation at EPU conditions (Reference 5) and remain unchanged. Therefore, the proposed amendments do not significantly increase the probability or consequences of a FHA.

The proposed amendments do not increase the probability of dropping a fuel transfer cask because they do not introduce any new heavy loads to the SFP and do not affect heavy load handling processes. Also, the insertion of Metamic rack inserts does not increase the consequences of the cask drop accident because the radiological source term of that accident is developed from a non-mechanistically derived quantity of damaged fuel stored in the spent fuel pool. Therefore, the proposed amendments do not significantly increase the probability or consequences of a cask drop accident.

Operation in accordance with the proposed amendment will not change the probability of a fuel mispositioning or inadvertent insert removal event because fuel and insert movement will continue to be controlled by approved fuel handling procedures. These procedures continue to require identification of the initial and target locations for each fuel assembly and insert that is moved. The consequences of a fuel mispositioning event are not changed because the reactivity analysis demonstrates that the same subcriticality criteria and requirements continue to be met for the worst-case fuel mispositioning event. The removal of an absorber insert from an analyzed array is bounded by the fuel mispositioning event.

Operation in accordance with the proposed amendment will not change the probability of a boron dilution event because the systems and events that could affect spent fuel pool soluble boron are unchanged. The consequences of a boron dilution event are unchanged because the proposed amendment reduces the soluble boron requirement below the currently required value and the maximum possible water volume displaced by the inserts is an insignificant fraction of the total spent fuel pool water volume.

Operation in accordance with the proposed amendment will not change the probability of a seismic event. The consequences of a seismic event are not significantly increased because the forcing functions for seismic excitation are not increased and because the mass of storage racks with Metamic inserts is not appreciably increased. Seismic analyses demonstrate adequate stress levels in the storage racks when inserts are installed.

Operation in accordance with the proposed amendment will not change the probability of a loss of SFP cooling event because the systems and events that could affect SFP cooling are unchanged. The consequences are not significantly increased because there are no changes in the SFP heat load or SFP cooling systems, structures or components. Furthermore, conservative analyses indicate that the current design requirements and criteria continue to be met with the Metamic inserts installed.

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

2. **Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?**

No. The proposed amendments do not change or modify the fuel, fuel handling processes, fuel racks, number of fuel assemblies that may be stored in the pool, decay heat generation rate, or the spent fuel pool cooling and cleanup system. The effects of operating with the proposed amendment are listed below. The proposed amendments were evaluated for the potential of each effect to create the possibility of a new or different kind of accident:

a. addition of inserts to the fuel storage racks,
b. new storage patterns,
c. additional weight from the inserts,
d. insert movement above fuel, and
e. displacement of fuel pool water by the inserts,

Each insert will be placed between a fuel assembly and the storage cell wall, taking up some of the space available on two sides of the fuel assembly. Tests confirm that the insert can be installed and removed without damaging the fuel assembly. Analyses demonstrate that the presence of the inserts does not adversely affect spent fuel cooling, seismic capability, or subcriticality. The aluminum (alloy 6061) and boron carbide materials of construction have been shown to be compatible with nuclear fuel, storage racks and spent fuel pool environments, and generate no adverse material interactions. Thus, placing the inserts into the spent fuel pool storage racks cannot cause a new or different kind of accident.

Operation with the proposed fuel storage patterns will not create a new or different kind of accident because fuel movement will continue to be controlled by approved fuel handling procedures. These procedures continue to require identification of the initial and target locations for each fuel assembly that is moved. There are no changes in the criteria or design requirements pertaining to fuel storage safety, including subcriticality requirements, and analyses demonstrate that the proposed storage patterns meet these requirements and criteria with adequate margins. Thus, the proposed storage patterns cannot cause a new or different kind of accident.

Operation with the added weight of the Metamic inserts will not create a new or different accident. The net effect of the adding the maximum number of inserts is to add less than one percent to the weight of the loaded racks. Furthermore, the analyses of the racks with Metamic inserts installed demonstrate that the stress levels in the rack modules continue to be considerably less than allowable stress limits. Thus, the added weight from the inserts cannot cause a new or different kind of accident.

Operation with insert movement above stored fuel will not create a new or different kind of accident. The insert with its handling tool weighs considerably less than the weight of a single fuel assembly. Single fuel assemblies are routinely moved safely over fuel assemblies and the same level of safety in design and operation will be maintained when moving the inserts. Furthermore, the effect of a dropped insert to block the top of a storage cell has been evaluated in thermal-hydraulic analyses. Thus, the movement of inserts cannot cause a new or different kind of accident.

Whereas the installed rack inserts will displace a very small fraction of the fuel pool water volume and impose a very small reduction in operator response time to previously-evaluated SFP accidents, the reduction will not promote a new or different kind of accident. Also, displacement of water along two sides of a stored fuel assembly may have some local reduction in the peripheral cooling flow; however, this effect would be small compared to the flow induced through the fuel assembly and would in no way promote a new or different kind of accident.

The accidents and events previously analyzed and presented in the Boraflex Remedy and Alternative Source Term LARs remain bounding. Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. **Does the proposed amendment involve a significant reduction in the margin of safety?**

No. The proposed change was evaluated for its effect on current margins of safety as they relate to criticality, structural integrity, and spent fuel heat removal capability.

The margin of safety for subcriticality required by 10 CFR 50.68 (b) (4) is unchanged. New criticality analysis confirms that operation in accordance with the proposed amendment continues to meet the required subcriticality margins.

The structural evaluations for the racks and spent fuel pool with Metamic inserts installed show that the rack and spent fuel pool are unimpaired by loading combinations during seismic motion, and there is no adverse seismic-induced interaction between the rack and Metamic inserts.

The proposed change does not affect spent fuel heat generation or the spent fuel pool cooling systems. A conservative analysis indicates that the design basis requirements and criteria for spent fuel cooling continue to be met with the Metamic inserts in place, and displacing coolant. Thermal hydraulic analysis of the local effects of an installed rack insert blocking peripheral flow show a small increase in local water and fuel clad temperatures, but will remain within acceptable limits including no departure from nucleate boiling.

Therefore, the proposed changes do not involve a significant reduction in the margin of safety.

Based on the above discussion, FPL has determined that the proposed change does not involve a significant hazards consideration.

8.0 Environmental Consideration

10 CFR 51.22(c)(9) provides criteria for and identification of licensing and regulatory actions eligible for categorical exclusion from performing an environmental assessment. A proposed amendment of an operating license for a facility requires no environmental assessment, if the operation of the facility in accordance with the proposed amendment does not: (1) involve a significant hazards consideration, (2) result in a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, and (3) result in a significant increase in individual or cumulative occupational radiation exposure. FPL has reviewed this LAR and determined that the proposed amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment needs to be prepared in connection with the issuance of this amendment. The basis for this determination follows.

Basis

This change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9) for the following reasons:

1. As demonstrated in the 10 CFR 50.92 evaluation, the proposed amendment does not involve a significant hazards consideration.

2. The proposed amendment does not result in a significant change in the types or increase in the amounts of any effluents that may be released offsite. Implementation of the proposed project involves two activities that could produce some form of radiological effluent: (1) spent fuel handling, and (2) insertion and removal of rack inserts. As many as several hundred spent fuel assemblies may be handled using established procedures, and several hundred Metamic rack inserts may also be installed at each unit. A modicum of solid low-level radioactive waste will be generated from the normal radiological waste generated from wipe-down of the above-water sections of the handling equipment during each fuel move, and protective clothing worn by personnel handling fuel. However, this quantity of waste is expected to be very small compared to that generated by a typical refueling outage.

Otherwise, performing the fuel movement campaign and installing Metamic inserts is not expected to generate any gaseous or liquid effluent that would not otherwise be generated in the course of routine spent fuel pool operations over its lifetime. For example, some waste filters may be generated as a result of vacuuming several hundred fuel assemblies to verify identification numbers; however, that waste and those operations would have to transpire sometime in the future anyhow. Installation and use of Metamic inserts is not expected to generate a significant amount of radwaste. The installation may dislodge some crud/silt; however, the amount is expected to be no more than that created by a typical refueling. The necessity for resin replacement of spent fuel pool purification media is determined primarily by the requirement for water clarity, which is not affected by the Metamic inserts. There is no mechanistic means to increase the volume of solid radioactive wastes due to the addition of Metamic inserts.

3. The proposed amendment does not result in a significant increase in individual or cumulative occupational radiation exposure. Implementation of the proposed amendments for each PTN unit will involve a several-month campaign of fuel movements and insert installations with personnel in the respective fuel handling building. Aside from the modicum of individual and cumulative occupational radiation exposure resulting from that campaign, the proposed amendments will not result in any permanent effects that would increase occupational exposure. The proposed fuel storage configurations and inserts do not fundamentally change the inventory or radiological source term of the spent fuel. In addition, based on FPL's experience with routine fuel movement campaigns during refueling outages and the fuel movement campaigns experienced during implementation of the Boraflex Remedy at Turkey Point, the cumulative exposure from the proposed activities is expected to be minimal.

9.0 Summary of Results

The criticality analysis evaluated the different 2x2 storage arrays that are designed to accommodate both fresh fuel and spent discharged fuel. The analysis confirmed the acceptability of each storage array in the spent fuel pool and the appropriate limitations to be placed on the use of each array noting that fuel of lower reactivity, i.e., greater burnup, than the maximum allowable may be placed in an array. The analysis demonstrated that the effective neutron multiplication factor (k_{eff}) of all permissible fuel storage arrangements is less than 0.95 when the storage racks are assumed to be flooded with borated water. The analysis also demonstrated that the k_{eff} is less than 0.95 under all postulated accident conditions. Finally, the analysis demonstrated that the k_{eff} of each fuel storage arrangement remains less than 1.0 when the pool is assumed to be flooded with unborated water.

Although allowable fuel enrichment remains unchanged by this submittal, the analysis shows that fresh fuel of up to 5.0 wt% U-235 could be stored in the cask area rack under fully flooded conditions and meet the applicable acceptance criteria. The analysis also demonstrated that a fuel rod basket can be placed in any fuel storage cell and in any region without restrictions.

10.0 References

1. M. Kiley (FPL) to U. S. Nuclear Regulatory Commission (L-2010-169), "License Amendment Request No. 207 Fuel Storage Criticality Analysis," Accession No. ML102220022, August 5, 2010.

2. NRC Draft Interim Staff Guidance DSS-ISG-2010-01, Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools.

3. Terry O. Jones (FPL) to U.S. Nuclear Regulatory Commission (L-2005-247), License Amendment Request No. 178 - Spent Fuel Pool Boraflex Remedy, January 27, 2006

4. Brenda L. Mozafari (NRC) to J. A. Stall (FPL), "Issuance of Amendments Regarding Spent Fuel Pool Boraflex Remedy (TAC Nos. MC9740 and MC9741)," July 17, 2007

5. W. Jefferson (FPL) to U.S. Nuclear Regulatory Commission (L-2009-133), "License Amendment Request 196: Alternative Source Term and Conforming Amendment," June 25, 2009.

Turkey Point Units 3 and 4

LAR NO. 207
FUEL STORAGE CRITICALITY ANALYSIS
SUPPLEMENT 1

ATTACHMENT 1

Operating License and Technical Specifications Markups

This coversheet plus 19 pages

5.5 FUEL STORAGE

5.5.1 CRITICALITY

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

a. A k_{eff} less than 1.0 when flooded with unborated water, which includes an allowance for biases and uncertainties as described in UFSAR Chapter 9.

b. A k_{eff} less than or equal to 0.95 when flooded with water borated to ~~650~~ 500 ppm, which includes an allowance for biases and uncertainties as described in UFSAR Chapter 9.

c. A nominal 10.6 inch center-to-center distance for Region I and 9.0 inch center-to-center distance for Region II for the two region spent fuel pool storage racks. A nominal 10.1 inch center-to-center distance in the east-west direction and a nominal 10.7 inch center-to-center distance in the north-south direction for the ~~Region I~~ cask area storage rack.

d. A maximum enrichment loading for fuel assemblies of 4.5 weight percent of U-235.

e. No restriction on storage of fresh or irradiated fuel assemblies in the cask area storage rack.

f. Fresh or irradiated fuel assemblies not stored in the cask area storage rack shall be stored in accordance with Specification 5.5.1.3 or configurations that have been shown to comply with Specification 5.5.1.1a and 5.5.1.1b using ~~the~~ NRC approved methodology in UFSAR Chapter 9.

5.5.1.2 The racks for new fuel storage are designed to store fuel in a safe subcritical array and shall be maintained with:

a. A nominal 21 inch center-to-center spacing to assure k_{eff} equal to or less than 0.98 for optimum moderation conditions and equal to or less than 0.95 for fully flooded conditions.

b. Fuel assemblies placed in the New Fuel Storage Area shall contain no more than 4.5 weight percent of U-235.

Unless otherwise specified in accordance with Specification 5.5.1.1.f, f

DESIGN FEATURES

5.5.1.3 Credit for burnup and cooling time is taken in determining acceptable placement locations for spent fuel in the two-region spent fuel racks. ~~Fresh or irradiated fuel assemblies shall be stored in compliance with the following:~~

a. Any 2x2 array of Region I storage cells containing fuel shall comply with the storage patterns in Figure 5.5-1 and the requirements of Tables ~~Table~~ 5.5-1 and 5.5-2, as applicable. The reactivity rank of fuel assemblies in the 2x2 array (rank determined using Table 5.5-3) shall be equal to or less reactive than that shown for the 2x2 array.

b. Any 2x2 array of Region II storage cells containing fuel shall:

i. Comply with the storage patterns in Figure 5.5-2 and the requirements of Tables ~~Table~~ 5.5-1 and 5.5-2, as applicable. The reactivity rank of fuel assemblies in the 2x2 array (rank determined using Table 5.5-3) shall be equal to or less reactive than that shown for the 2x2 array,

ii. Have the same directional orientation for Metamic inserts in a contiguous group of 2x2 arrays where Metamic inserts are required, and

iii. Comply with the requirements of 5.5.1.3.c for cells adjacent to Region I racks~~, and~~ .

~~iv. Comply with the requirements of 5.5.1.3.d for cells adjacent to the spent fuel pit walls.~~

c. Any 2x2 array of Region II storage cells that interface with Region I storage cells shall comply with the rules of Figure 5.5-3. ~~Arrays II-E and II-F may interface with Region I without special restriction.~~

d. ~~Any 2x2 array of Region II storage cells may adjoin a row of assemblies with a reactivity rank of II-2 (or lower) that is located in the outer row adjacent to the spent fuel pit wall. The outer row of reactivity rank II-2 (or lower) fuel assemblies need not contain any Metamic inserts or full length RCCAs, as long as the following additional requirements are met:~~

Any fuel assembly may be replaced with a fuel rod storage basket or non-fuel hardware.

~~i. Fuel is loaded to comply with the allowable storage patterns defined in Figure 5.5-4, and~~

~~ii. Arrays II-E and II-F are loaded without any additional restriction on that 2x2 array. Arrays II-E and II-F do not have empty cells, Metamic inserts, or RCCAs that restrict the interface with the adjoining reactivity rank II-2 (or lower) fuel assemblies.~~

e. Storage of Metamic inserts or RCCAs is acceptable in locations designated as empty (water-filled) cells.

DRAINAGE

5.5.2 The spent fuel storage pit is designed and shall be maintained to prevent inadvertent draining of the pool below a level of 6 feet above the fuel assemblies in the storage racks.

CAPACITY

5.5.3 The spent fuel pool storage racks are designed and shall be maintained with a storage capacity limited to no more than 1404 fuel assemblies in two region storage racks, and the cask area storage rack is designed and shall be maintained with a storage capacity limited to no more than 131 fuel assemblies. The total spent fuel pool storage capacity is limited to no more than 1535 fuel assemblies.

REPLACE TABLE 5.5-1
WITH THE NEXT PAGE

Table 5.5-1

Blanketed Fuel - Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See note 1 for use of Table 5.5-1

Fuel Category	Blanketed Fuel Storage Curve Coefficients[1]							Blanketed Fuel Minimum Burnup[1] (GWd/MTU) for Initial Enrichment[2]					
	A	B	C	D	E	F	G	Cooling Time[3]	2.5 w%	3.0 w%	3.3 w%	4.0 w%	4.5 w%
I-1[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I-2	18.8602	-1.090486	0.266387	-0.00474496	-0.158563	0.00314739	-30.1637	0	10.17	16.60	20.20	27.83	32.62
								2.5	9.87	16.11	19.59	26.96	31.57
								5	9.60	15.67	19.06	26.19	30.62
								10	9.18	14.98	18.20	24.94	29.10
								15	8.92	14.52	17.62	24.08	28.04
								20	8.82	14.30	17.32	23.61	27.45
II-1	16.2639	-0.712257	0.175883	-0.00399237	-0.166686	0.00370969	-19.5118	0	16.70	22.87	26.40	34.15	39.25
								2.5	16.13	22.10	25.52	32.99	37.90
								5	15.62	21.43	24.74	31.96	36.70
								10	14.82	20.34	23.49	30.32	34.78
								15	14.27	19.61	22.65	29.23	33.50
								20	13.99	19.24	22.22	28.67	32.85
II-2	14.4600	-0.372732	0.132275	-0.00617104	-0.187813	0.00526411	-12.8293	0	20.99	27.20	30.83	39.05	44.69
								2.5	20.19	26.18	29.68	37.59	43.02
								5	19.48	25.28	28.67	36.32	41.57
								10	18.32	23.85	27.07	34.35	39.32
								15	17.50	22.89	26.04	33.11	37.94
								20	17.04	22.42	25.56	32.62	37.44
II-3	15.4624	-0.501267	-0.06553	0.00160009	-0.161078	0.00340497	-11.2483	0	24.27	30.63	34.32	42.58	48.18
								2.5	23.17	29.33	32.91	40.90	46.31
								5	22.19	28.18	31.65	39.41	44.65
								10	20.60	26.32	29.63	37.00	41.97
								15	19.53	25.05	28.25	35.36	40.13
								20	18.96	24.38	27.51	34.47	39.14

Table 5.5-1 (continued)

Blanketed Fuel - Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See note 1 for use of Table 5.5-1

Fuel Category	Blanketed Fuel Storage Curve Coefficients[1]							Blanketed Fuel Minimum Burnup[1] (GWd/MTU) for Initial Enrichment[2]					
	A	B	C	D	E	F	G	Cooling Time[3]	2.5 w%	3.0 w%	3.3 w%	4.0 w%	4.5 w%
II-4	15.3172	-0.444842	-0.114363	0.00273060	-0.162664	0.00344467	-9.1868	0	26.33	32.76	36.52	44.96	50.73
								2.5	25.09	31.34	34.98	43.16	48.73
								5	24.00	30.08	33.61	41.55	46.96
								10	22.25	28.04	31.41	38.97	44.09
								15	21.06	26.67	29.92	37.20	42.14
								20	20.44	25.94	29.13	36.27	41.10
II-5	15.1701	-0.387768	-0.163521	0.00394514	-0.164014	0.00345174	-7.1273	0	28.37	34.89	38.71	47.35	53.29
								2.5	27.02	33.34	37.05	45.41	51.15
								5	25.82	31.97	35.57	43.69	49.26
								10	23.90	29.77	33.20	40.93	46.22
								15	22.60	28.28	31.59	39.05	44.14
								20	21.93	27.50	30.75	38.06	43.05
II-6	13.4516	-0.078364	-0.266734	0.00288411	-0.147006	0.00446530	-3.3460	0	29.79	36.30	40.19	49.21	55.60
								2.5	28.30	34.64	38.42	47.20	53.42
								5	26.97	33.17	36.87	45.45	51.53
								10	24.86	30.85	34.43	42.73	48.61
								15	23.44	29.35	32.88	41.05	46.85
								20	22.73	28.66	32.20	40.41	46.23
II-7	13.7900	-0.086680	-0.355570	0.00574698	-0.145745	0.00426994	-2.0705	0	31.86	38.52	42.49	51.70	58.23
								2.5	30.17	36.65	40.53	49.50	55.86
								5	28.67	35.02	38.81	47.58	53.80
								10	26.31	32.45	36.11	44.60	50.61
								15	24.76	30.80	34.41	42.76	48.67
								20	24.03	30.09	33.70	42.06	47.99

~~Table 5.5-1 (continued)~~

Blanketed Fuel - Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See note 1 for use of Table 5.5-1

Fuel Category	Blanketed Fuel Storage Curve Coefficients[1]							Blanketed Fuel Minimum Burnup[1] (GWd/MTU) for Initial Enrichment[2]					
	A	B	C	D	E	F	G	Cooling Time[3]	2.5 w%	3.0 w%	3.3 w%	4.0 w%	4.5 w%
II-8	14.1212	-0.094016	-0.448138	0.00877894	-0.143511	0.00402944	-0.7808	0	33.93	40.74	44.80	54.20	60.86
								2.5	32.04	38.67	42.63	51.80	58.29
								5	30.37	36.86	40.74	49.71	56.06
								10	27.75	34.04	37.79	46.47	52.61
								15	26.07	32.25	35.94	44.47	50.51
								20	25.34	31.51	35.19	43.71	49.75

Notes

1. All relevant uncertainties are explicitly included in the criticality analysis. For instance, no additional allowance for burnup uncertainty is required. For a fuel assembly to meet the requirements of a Fuel Category, the assembly burnup must exceed the "minimum burnup" given in the table for the assembly "cooling time" and "initial enrichment." Alternatively, the specific minimum burnup required for each fuel assembly may be calculated from the following equation: $Bu = A \times En + B \times En^2 + C \times Ct + D \times Ct^2 + E \times Ct \times En + F \times Ct^2 \times En + G$. Only cooling times of 0, 2.5, 5, 10, 15 and 20 years may be used in this equation. Actual cooling time (Ct) is rounded down to the nearest value.
2. Nominal central zone U-235 enrichment: Axial blanket material is not considered when determining enrichment.
3. Cooling time in years.
4. Fresh unburned fuel up to 4.5 w% U-235 enrichment: No burnup is required.

INSERT FOR TABLE 5.5-1

Table 5.5-1

Blanketed Fuel – Coefficients to Calculate the Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See notes 1-6 for use of Table 5.5-1

Coeff.	**Fuel Category**						
	I-3	**I-4**	**II-1**	**II-2**	**II-3**	**II-4**	**II-5**
A1	5.66439153	-14.7363682	-7.74060457	-7.63345029	24.4656526	8.5452608	26.2860949
A2	-7.22610116	11.0284547	5.13978237	10.7798957	-20.3141124	-4.47257395	-18.0738662
A3	2.98646188	-1.80672781	-0.360186309	-2.81231555	6.53101471	2.09078914	5.8330891
A4	-0.287945644	0.119516492	0.0021681285	0.29284474	-0.581826027	-0.188280562	-0.517434342
A5	-0.558098618	0.0620559676	-0.0304713673	0.0795058096	-0.16567492	0.157548739	-0.0614152031
A6	0.476169245	0.0236575787	0.098844889	-0.0676341983	0.243843226	-0.0593584027	0.134626308
A7	-0.117591963	-0.0088144551	-0.0277584786	0.0335130877	-0.0712130368	0.0154678626	-0.0383060399
A8	0.0095165354	0.0008957348	0.0024057185	-0.0040803875	0.0063998706	-0.0014068318	0.0033419846
A9	-47.1782783	-20.2890089	-21.424984	14.6716317	-41.1150	-0.881964768	-12.1780
A10	33.4270029	14.7485847	16.255208	-10.0312224	43.9149156	9.69128392	23.6179517
A11	-6.11257501	-1.22889103	-1.77941882	5.62580894	-9.6599923	-0.18740168	-4.10815592
A12	0.490064351	0.0807808548	0.127321203	-0.539361868	0.836931842	0.0123398618	0.363908736

Notes:

1. All relevant uncertainties are explicitly included in the criticality analysis. For instance, no additional allowance for burnup uncertainty or enrichment uncertainty is required. For a fuel assembly to meet the requirements of a Fuel Category, the assembly burnup must exceed the "minimum burnup" (GWd/MTU) given by the curve fit for the assembly "cooling time" and "initial enrichment." The specific minimum burnup required for each fuel assembly is calculated from the following equation:

$$\mathbf{Bu = (A_1 + A_2{*}En + A_3{*}En^2 + A_4{*}En^3){*}\ exp\ [\ \text{-}\ (A_5 + A_6{*}En + A_7{*}En^2 + A_8{*}En^3){*}Ct\ ]}$$
$$\mathbf{+ A_9 + A_{10}{*}En + A_{11}{*}En^2 + A_{12}{*}En^3}$$

2. Initial enrichment, En, is the nominal central zone U-235 enrichment. Axial blanket material is not considered when determining enrichment. Any enrichment between 2.0 and 5.0 may be used.
3. Cooling time, Ct, is in years. Any cooling time between 0 years and 25 years may be used. An assembly with a cooling time greater than 25 years must use 25 years.
4. Category I-1 is fresh unburned fuel up to 5.0 wt% U-235 enrichment.
5. Category I-2 is fresh unburned fuel that obeys the IFBA requirements in Table 5.5-4 or contains an equivalent amount of another burnable absorber.
6. This Table applies for any blanketed fuel assembly.

REPLACE TABLE 5.5-2
WITH THE NEXT PAGE

Table 5.5-2

Non-Blanketed Fuel - Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See note 1 for use of Table 5.5-2

Fuel Category	Non-Blanketed Fuel Storage Curve Coefficients[1]							Non-Blanketed Fuel Minimum Burnup[1] (GWd/MTU) for Initial Enrichment[2]					
	A	B	C	D	E	F	G	Cooling Time[3]	1.8 w%	2.5 w%	3.0 w%	3.5 w%	4.0 w%
I-1[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I-2	18.1371	-0.944126	0.253120	-0.00553408	-0.151450	0.00334051	-29.3574	0	0.23	10.08	16.56	22.56	28.08
								2.5	0.18	9.79	16.08	21.90	27.25
								5	0.14	9.53	15.66	21.33	26.52
								10	0.08	9.11	14.99	20.40	25.34
								15	0.05	8.84	14.55	19.79	24.56
								20	0.03	8.70	14.33	19.48	24.16
II-1	11.9800	0.158287	0.237665	-0.00688305	-0.192273	0.00492032	-14.2029	0	7.87	16.74	23.16	29.67	36.25
								2.5	7.62	16.16	22.36	28.64	35.00
								5	7.38	15.66	21.66	27.75	33.91
								10	6.99	14.85	20.56	26.35	32.22
								15	6.69	14.31	19.85	25.46	31.16
								20	6.49	14.04	19.53	25.10	30.74
II-2	11.8419	0.287918	0.113820	-0.00527641	-0.175033	0.00507248	-9.9305	0	12.32	21.47	28.19	35.04	42.04
								2.5	11.84	20.71	27.22	33.87	40.67
								5	11.41	20.04	26.38	32.86	39.49
								10	10.69	18.98	25.07	31.30	37.68
								15	10.17	18.28	24.25	30.37	36.63
								20	9.83	17.96	23.94	30.06	36.32
II-3	12.6055	0.361578	-0.075193	0.00118870	-0.152297	0.00386780	-8.6212	0	15.24	25.15	32.45	39.93	47.59
								2.5	14.42	24.08	31.20	38.50	45.98
								5	13.70	23.14	30.11	37.25	44.58
								10	12.56	21.68	28.41	35.32	42.41
								15	11.83	20.76	27.35	34.12	41.07
								20	11.51	20.38	26.92	33.65	40.56

Table 5.5-2 (continued)

Non-Blanketed Fuel - Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See note 1 for use of Table 5.5-2

Fuel Category	Non-Blanketed Fuel Storage Curve Coefficients[1]							Non-Blanketed Fuel Minimum Burnup[1] (GWd/MTU) for Initial Enrichment[2]					
	A	B	C	D	E	F	G	Cooling Time[3]	1.8 w%	2.5 w%	3.0 w%	3.5 w%	4.0 w%
II-4	12.6130	0.436168	-0.128105	0.00275389	-0.151579	0.00377707	-7.0392	0	17.08	27.22	34.73	42.45	50.39
								2.5	16.13	26.03	33.36	40.90	48.67
								5	15.31	24.99	32.16	39.56	47.17
								10	14.02	23.37	30.31	37.46	44.83
								15	13.21	22.36	29.15	36.16	43.39
								20	12.88	21.96	28.70	35.67	42.85
II-5	12.6086	0.517311	-0.185177	0.00442008	-0.150482	0.00367344	-5.3438	0	19.03	29.41	37.14	45.12	53.37
								2.5	17.96	28.09	35.64	43.45	51.52
								5	17.02	26.94	34.34	42.00	49.91
								10	15.57	25.16	32.32	39.73	47.41
								15	14.67	24.05	31.06	38.33	45.86
								20	14.32	23.62	30.58	37.80	45.27
II-6	17.1055	-0.116940	0.024104	-0.00410005	-0.262366	0.00761230	-10.7361	0	19.67	31.30	39.53	47.70	55.81
								2.5	18.61	29.81	37.74	45.61	53.42
								5	17.67	28.51	36.18	43.79	51.35
								10	16.15	26.47	33.77	41.01	48.20
								15	15.11	25.18	32.30	39.36	46.36
								20	14.55	24.63	31.76	38.83	45.85
II-7	17.5099	-0.130912	-0.143634	0.00199657	-0.235656	0.00625103	-9.1041	0	21.99	33.85	42.25	50.58	58.84
								2.5	20.65	32.13	40.25	48.31	56.29
								5	19.48	30.63	38.51	46.33	54.08
								10	17.64	28.29	35.82	43.28	50.68
								15	16.45	26.83	34.16	41.42	48.62
								20	15.93	26.25	33.54	40.76	47.92

Table 5.5-2 (continued)

Non-Blanketed Fuel - Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See note 1 for use of Table 5.5-2

Fuel Category	Non-Blanketed Fuel Storage Curve Coefficients[1]							Non-Blanketed Fuel Minimum Burnup[1] (GWd/MTU) for Initial Enrichment[2]					
	A	B	C	D	E	F	G	Cooling Time[3]	1.8 w%	2.5 w%	3.0 w%	3.5 w%	4.0 w%
II-8	17.9109	-0.143928	-0.308137	0.00796481	-0.209912	0.00492410	-7.4704	0	24.30	36.41	44.97	53.45	61.87
								2.5	22.69	34.45	42.76	51.01	59.17
								5	21.29	32.75	40.85	48.87	56.82
								10	19.13	30.11	37.86	45.55	53.16
								15	17.80	28.48	36.01	43.48	50.88
								20	17.31	27.86	35.30	42.68	49.98

Notes

1. All relevant uncertainties are explicitly included in the criticality analysis. For instance, no additional allowance for burnup uncertainty is required. For a fuel assembly to meet the requirements of a Fuel Category, the assembly burnup must exceed the "minimum burnup" given in the table for the assembly "cooling time" and "initial enrichment." Alternatively, the specific minimum burnup required for each fuel assembly may be calculated from the following equation: $Bu = A \times En + B \times En^2 + C \times Ct + D \times Ct^2 + E \times Ct \times En + F \times Ct^2 \times En + G$. Only cooling times of 0, 2.5, 5, 10, 15 and 20 years may be used in this equation. Actual cooling time (Ct) is rounded down to the nearest value.

2. Nominal U-235 enrichment.

3. Cooling time in years.

4. Fresh unirradiated fuel up to 4.5 w% U-235 enrichment: No burnup is required.

INSERT FOR TABLE 5.5-2

Table 5.5-2

Non-Blanketed Fuel – Coefficients to Calculate the Minimum Required Fuel Assembly Burnup (Bu) as a Function of Enrichment (En) and Cooling Time (Ct)

See notes 1-4 for use of Table 5.5-2

	Fuel Category						
Coeff.	**I-3**	**I-4**	**II-1**	**II-2**	**II-3**	**II-4**	**II-5**
A1	2.04088171	-27.6637884	-11.2686777	20.7284208	29.8862876	-83.5409405	35.5058622
A2	-4.83684164	26.1997193	2.0659501	11.9673275	-37.0771132	94.7973724	-30.1986997
A3	2.59801889	-7.2982252	2.66204924	-14.4072388	16.3986049	-31.9583373	11.0102438
A4	-0.300597247	0.723731768	-0.513334362	2.83623963	-2.1571669	3.55898487	-1.27269125
A5	-0.610041808	0.401332891	-0.0987986108	-1.49118695	1.02330848	0.299948492	1.34723758
A6	0.640497159	-0.418616707	-0.0724198633	1.75361041	-1.21889631	-0.312341996	-1.19871392
A7	-0.219000712	0.144304039	0.106248806	-0.659046438	0.467440882	0.107463895	0.352920811
A8	0.0252870451	-0.0154239536	-0.0197359109	0.080884618	-0.0560129443	-0.0108814287	-0.0325155213
A9	-4.48207836	-5.54507376	-1.34620551	-245.825283	12.1549	39.4975573	-5.2576
A10	-2.12118634	-5.76555416	-10.1728821	243.59979	-22.7755385	-50.5818253	10.1733379
A11	2.91619317	6.29118025	8.71968815	-75.7805818	14.3755458	23.3093829	0.369083041
A12	-0.196645176	-0.732079719	-1.14461356	8.10936356	-1.80803352	-2.69466612	0.0443577624

Notes:

1. All relevant uncertainties are explicitly included in the criticality analysis. For instance, no additional allowance for burnup uncertainty or enrichment uncertainty is required. For a fuel assembly to meet the requirements of a Fuel Category, the assembly burnup must exceed the "minimum burnup" (GWd/MTU) given by the curve fit for the assembly "cooling time" and "initial enrichment." The specific minimum burnup required for each fuel assembly is calculated from the following equation:

$$\mathbf{Bu = (A_1 + A_2*En + A_3*En^2 + A_4*En^3)* \exp [- (A_5 + A_6*En + A_7*En^2 + A_8*En^3)*Ct]}$$
$$\mathbf{+ A_9 + A_{10}*En + A_{11}*En^2 + A_{12}*En^3}$$

2. Initial enrichment, En, is the nominal U-235 enrichment. Any enrichment between 1.8 and 4.0 may be used.
3. Cooling time, Ct, is in years. Any cooling time between 15 years and 25 years may be used. An assembly with a cooling time greater than 25 years must use 25 years.
4. This Table applies only for pre-EPU non-blanketed fuel assemblies. If a non-blanketed assembly is depleted at EPU conditions, none of the burnup accrued at EPU conditions can be credited (i.e., only burnup accrued at pre-EPU conditions may be used as burnup credit).

REPLACE TABLE 5.5-3 WITH THE NEXT PAGE

Table 5.5-3

Fuel Categories Ranked by Reactivity[1]

Fuel Category	
Region I	Region II
I-1	II-1
I-2	II-2
	II-3
	II-4
	II-5
	II-6
	II-7
	II-8

Notes

1. Reactivity Rank: Fuel Category is ranked in decreasing order of reactivity, e.g. II-2 is less reactive than II-1, etc.

INSERT FOR TABLE 5.5-3

Table 5.5-3

Fuel Categories Ranked by Reactivity

See notes 1-5 for use of Table 5.5-3

Region I	I-1	High Reactivity
	I-2	
	I-3	
	I-4	Low Reactivity
Region II	II-1	High Reactivity
	II-2	
	II-3	
	II-4	
	II-5	Low Reactivity

Notes:

1. Fuel Category is ranked by decreasing order of reactivity without regard for any reactivity-reducing mechanisms, e.g., Category I-2 is less reactive than Category I-1, etc. The more reactive fuel categories require compensatory measures to be placed in Regions I and II of the SFP, e.g., use of water filled cells, Metamic inserts, or full length RCCAs.
2. Any higher numbered fuel category can be used in place of a lower numbered fuel category from the same Region.
3. Category I-1 is fresh unburned fuel up to 5.0 wt% U-235 enrichment.
4. Category I-2 is fresh unburned fuel that obeys the IFBA requirements of Table 5.5-4 or contains an equivalent amount of another burnable absorber.
5. All Categories except I-1 and I-2 are determined from Tables 5.5-1 and 5.5-2.

Table 5.5-4

IFBA Requirements for Fuel Category I-2

Nominal Enrichment (wt% U-235)	Minimum Required Number of IFBA Pins
Enr. ≤ 4.3	0
4.3 < Enr. ≤ 4.4	32
4.4 < Enr. ≤ 4.7	64
4.7 < Enr. ≤ 5.0	80

REPLACE FIGURE 5.5-1
WITH THE NEXT PAGE

FIGURE 5.5-1

ALLOWABLE REGION I STORAGE ARRAYS

DEFINITION[1,4]

ILLUSTRATION[1,2,3,4]

Array I-A
Checkerboard pattern of Category I-1 assemblies and empty (water filled) cells.

I-1	E
E	I-1

Array I-B
Category I-2 assembly in every cell.

I-2	I-2
I-2	I-2

Array I-C
Category I-1 assemblies and Category I-2 assemblies: Each Category I-1 assembly shall have a full length RCCA in the assembly. The number of Category I-1 assemblies with RCCAs in the assemblies is unrestricted.

I-1	I-2
I-2	I-2

I-1	I-1
I-2	I-2

I-1	I-1
I-2	I-1

I-1	I-1
I-1	I-1

Notes:

1. Fuel Categories are determined from Tables 5.5-1 and 5.5-2.
2. Shaded cells indicate the fuel assembly contains a full length RCCA.
3. **E** indicates an empty (water filled) cell.
4. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only.

INSERT FOR
FIGURE 5.5-1

FIGURE 5.5-1

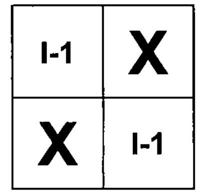
ALLOWABLE REGION I STORAGE ARRAYS

See notes 1-8 for use of Figure 5.5-1

DEFINITION **ILLUSTRATION**

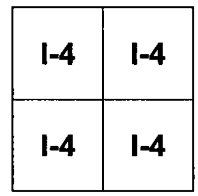
Array I-A

Checkerboard pattern of Category I-1 assemblies and empty (water-filled) cells.



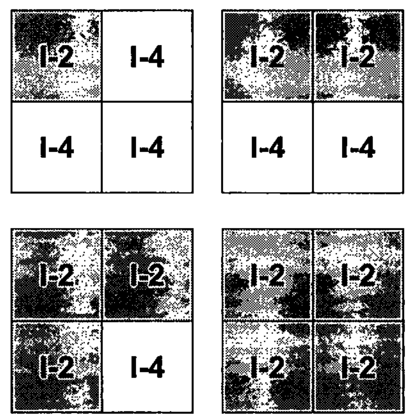
Array I-B

Category I-4 assembly in every cell.



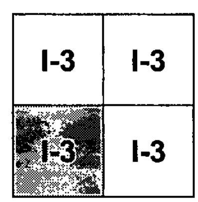
Array I-C

Combination of Category I-2 and I-4 assemblies. Each Category I-2 assembly shall contain a full length RCCA.



Array I-D

Category I-3 assembly in every cell. One of every four assemblies contains a full length RCCA



Notes:

1. In all arrays, an assembly of lower reactivity can replace an assembly of higher reactivity.
2. Category I-1 is fresh unburned fuel up to 5.0 wt% U-235 enrichment.
3. Category I-2 is fresh unburned fuel that obeys the IFBA requirements in Table 5.5-4 or contains an equivalent amount of another burnable absorber.
4. Categories I-3 and I-4 are determined from Tables 5.5-1 and 5.5-2.
5. Shaded cells indicate that the fuel assembly contains a full length RCCA.
6. **X** indicates an empty (water-filled) cell.
7. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only.
8. An empty (water-filled) cell may be substituted for any fuel containing cell in all storage arrays.

REPLACE FIGURE 5.5-2
WITH THE NEXT PAGE

FIGURE 5.5-2

ALLOWABLE REGION II STORAGE ARRAYS

DEFINITION[1,4] | **ILLUSTRATION[1,2,3,4]**

Array II-A
Category II-1 assembly in three of every four cells:
One of every four cells is empty (water-filled).

II-1	II-1
II-1	E

Array II-B
Category II-2 assembly in every cell: Two of every four cells contain a Metamic insert (or full length RCCA in the assembly).

II-2	II-2
II-2	II-2

II-2	II-2
II-2	II-2

II-2	II-2
II-2	II-2

Array II-C
Checkerboard pattern of Category II-3 and II-5 assemblies:
One of every four cells contains a Metamic insert (or full length RCCA in the assembly). Metamic inserts (or RCCAs) may be in either II-3 or II-5 cells.

II-3	II-5
II-5	II-3

II-5	II-3
II-3	II-5

Array II-D
Category II-4 assembly in every cell: One of every four cells contains a Metamic insert (or full length RCCA in the assembly).

II-4	II-4
II-4	II-4

Array II-E
Checkerboard pattern of Category II-6 and II-8 assemblies.

II-8	II-6
II-6	II-8

Array II-F
Category II-7 assembly in every cell.

II-7	II-7
II-7	II-7

Notes:

1. Fuel Categories are determined from Tables 5.5-1 and 5.5-2.
2. Shaded cells indicate either a Metamic insert in the cell or the fuel assembly contains a full length RCCA.
3. E indicates an empty (water filled) cell.
4. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only.

INSERT FOR FIGURE 5.5-2

FIGURE 5.5-2

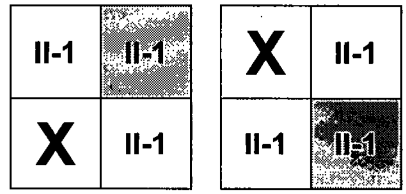
ALLOWABLE REGION II STORAGE ARRAYS

See notes 1-6 for use of Figure 5.5-2

DEFINITION | **ILLUSTRATION**

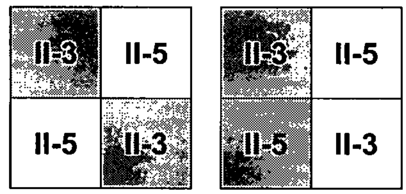
Array II-A

Category II-1 assembly in three of every four cells; one of every four cells is empty (water-filled); the cell diagonal from the empty cell contains a Metamic insert or full length RCCA.



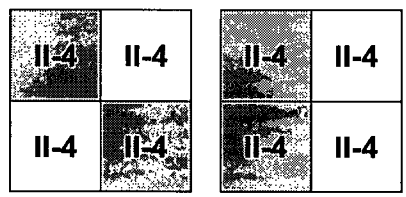
Array II-B

Checkerboard pattern of Category II-3 and II-5 assemblies with two of every four cells containing a Metamic insert or full length RCCA.



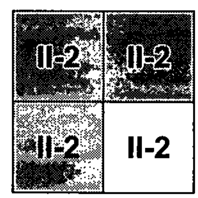
Array II-C

Category II-4 assembly in every cell with two of every four cells containing a Metamic insert or full length RCCA.



Array II-D

Category II-2 assembly in every cell with three of every four cells containing a Metamic insert or full length RCCA.



Notes:

1. In all arrays, an assembly of lower reactivity can replace an assembly of higher reactivity.
2. Fuel categories are determined from Tables 5.5-1 and 5.5-2.
3. Shaded cells indicate that the cell contains a Metamic insert or the fuel assembly contains a full length RCCA.
4. **X** indicates an empty (water-filled) cell.
5. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only.
6. An empty (water-filled) cell may be substituted for any fuel containing cell in all storage arrays.

REPLACE FIGURE 5.5-3
WITH THE NEXT PAGE

FIGURE 5.5-3

ALLOWABLE INTERFACES BETWEEN REGION II – REGION I ARRAYS

DEFINITION[1,4]

ILLUSTRATION[1,2,3,4,5]

For Array II-A, the empty cell shall be in the row adjacent to the Region I Rack.

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-1	E	II-1	E
II-1	II-1	II-1	II-1

Array II-A

For Array II-B, the reactivity rank of assemblies adjacent to the Region I rack shall be reduced from a rank of II-2 to a reactivity rank of II-4 or lower. The Array II-B pattern shall have the required Metamic insert (or full length RCCA in the assembly) placed in the row adjacent to the Region I rack.

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-4	II-4	II-4	II-4
II-2	II-2	II-2	II-2

Array II-B

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-4	II-4	II-4	II-4
II-2	II-2	II-2	II-2

Array II-B

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-4	II-4	II-4	II-4
II-2	II-2	II-2	II-2

Array II-B

For Arrays II-C and II-D, the Metamic insert (or full length RCCA in the assembly) shall be placed in the row adjacent to the Region I rack.

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-3	II-5	II-3	II-5
II-5	II-3	II-5	II-3

Array II-C

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-5	II-3	II-5	II-3
II-3	II-5	II-3	II-5

Array II-C

Region I Rack

I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2
II-4	II-4	II-4	II-4
II-4	II-4	II-4	II-4

Array II-D

Notes:

1. Fuel Categories are determined from Tables 5.5-1 and 5.5-2.
2. Shaded cells indicate either a Metamic insert in the cell or the fuel assembly contains a full length RCCA.
3. **E** indicates an empty (water filled) cell.
4. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only.
5. Region I Array I-2 is depicted as the example; however, any Region I array is equally representative.

INSERT FOR
FIGURE 5.5-3

FIGURE 5.5-3

INTERFACE RESTRICTIONS BETWEEN REGION I AND REGION II ARRAYS

See notes 1-8 for use of Figure 5.5-3

DEFINITION | **ILLUSTRATION**

Array II-A, as defined in Figure 5.5-2, when placed on the interface with Region I shall have the empty cell in the row adjacent to the Region I rack.

Region I Rack

I-4	I-4	I-4	I-4
I-4	I-4	I-4	I-4
II-1	X	II-1	X
II-1	II-1	II-1	II-1

Array II-A

Arrays II-B, II-C and II-D, as defined in Figure 5.5-2, when placed on the interface with Region I shall have an insert in every cell in the row adjacent to the Region I rack.

Region I Rack

I-4	I-4	I-4	I-4
I-4	I-4	I-4	I-4
II-3	II-5	II-3	II-5
II-5	II-3	II-5	II-3

Array II-B

Region I Rack

I-4	I-4	I-4	I-4
I-4	I-4	I-4	I-4
II-4	II-4	II-4	II-4
II-4	II-4	II-4	II-4

Array II-C

Region I Rack

I-4	I-4	I-4	I-4
I-4	I-4	I-4	I-4
II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2

Array II-D

Notes:

1. In all arrays, an assembly of lower reactivity can replace an assembly of higher reactivity.
2. Fuel categories are determined from Tables 5.5-1 and 5.5-2.
3. Shaded cells indicate that the cell contains a Metamic insert or the fuel assembly contains a full length RCCA.
4. **X** indicates an empty (water-filled) cell.
5. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only. Region I Array I-B is depicted as the example; however, any Region I array is allowed provided that

    a. For Array I-D, the RCCA shall be in the row adjacent to the Region II rack, and

    b. Array I-A shall not interface with Array II-D.
6. If no fuel is stored adjacent to Region II in Region I, then the interface restrictions are not applicable.
7. Figure 5.5-3 is applicable only to the Region I – Region II interface. There are no restrictions for the interfaces with the cask area rack.
8. An empty (water-filled) cell may be substituted for any fuel containing cell in all storage arrays.

FIGURE 5.5-4

ALLOWABLE REGION II STORAGE ADJACENT TO SPENT FUEL PIT WALLS

DEFINITION[1,4]

ILLUSTRATION[1,2,3,4]

An assembly of rank II-2 placed in the peripheral row of a Region II storage rack shall not be adjacent to a Region I storage rack.

Spent Fuel Pit Wall

II-2	II-2	II-2	II-3
II-3	II-5	II-3	II-5
II-5	II-3	II-5	II-3

Region 2 (Array II-C)

I-2	I-2	I-2	I-2	I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2	I-2	I-2	I-2	I-2
I-2	I-2	I-2	I-2	I-2	I-2	I-2	I-2

Region I (Array I-B)

For Array II-A, the empty cell in the 2x2 II-A array shall be adjacent to the peripheral row that contains the category II-2 assembly(s). For Array II-A only, the peripheral row may contain category II-1 assemblies as the outer two rows will comply with Array II-A requirements.

Spent Fuel Pit Wall

II-2	II-2	II-2	II-2
II-1	E	II-1	E
II-1	II-1	II-1	II-1

Array II-A

II-1	II-1	II-1	II-1
II-1	E	II-1	E
II-1	II-1	II-1	II-1

Array II-A

For Array II-B, the Metamic insert (or full length RCCA in the assembly) shall be adjacent to the peripheral row that contains the category II-2 assembly(s).

Spent Fuel Pit Wall

II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2

Array II-B

II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2

Array II-B

II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2
II-2	II-2	II-2	II-2

Array II-B

For Arrays II-C and II-D, the Metamic insert (or full length RCCA in the assembly) shall be adjacent to the peripheral row that contains the category II-2 assembly(s).

Spent Fuel Pit Wall

II-2	II-2	II-2	II-2
II-5	II-3	II-5	II-3
II-3	II-5	II-3	II-5

Array II-C

II-2	II-2	II-2	II-2
II-5	II-3	II-5	II-3
II-3	II-5	II-3	II-5

Array II-C

II-2	II-2	II-2	II-2
II-4	II-4	II-4	II-4
II-4	II-4	II-4	II-4

Array II-D

Notes:

1. Fuel Categories are determined from Tables 5.5-1 and 5.5-2.
2. Shaded cells indicate either a Metamic insert in the cell or the fuel assembly contains a full length RCCA.
3. E indicates an empty (water filled) cell.
4. Attributes for each 2x2 array are as stated in the definition. Diagram is for illustrative purposes only.