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Your ref: Docket No. 52-006
Our ref: DCP/NRC2511

May 29, 2009

Subject: AP1000 Response to Request for Additional Information (SRP 9)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 9. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-SRP9.1.1-SRSB-05

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk

Robert Sisk, Manager
Licensing and Customer Interface
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/Enclosure

1. Response to Request for Additional Information on SRP Section 9

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 9

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.1.1-SRSB-05
Revision: 0

Question:

DCD Section 9.1.6.4 "Criticality Analysis for Spent Fuel Racks" references TR-65 (APP-GW-GLR-029), which utilizes the methodology described in WCAP 14416-NP-A. A 2001 NRC letter (ML012080337) states that WCAP 14416-NP-A can no longer be relied upon as "approved methodology." The staff has found that the AP1000 methodology does not accurately calculate a spent fuel pool criticality analysis that meets 10 CFR 50.68.

Additionally, TR-65 relies on the same overall methodology used for multiple, recently submitted operating fleet spent fuel pool criticality analyses which were not accepted by the NRC. One example; a May 17, 2007 letter (ML071230037) issued an RAI against the June 14, 2006 Beaver Valley Power Station (BVPS) license amendment request. This BVPS RAI, and the process that followed, resulted in licensee commitments to work towards a license amendment that meets the requirements of 10 CFR 50.68. The NRC feels that Westinghouse is familiar with this spent fuel pool criticality analysis issue as it relates to BVPS and other utilities. The NRC requests Westinghouse re-submit the AP1000 spent fuel pool criticality analysis with a new methodology that meets 10 CFR 50.68.

Westinghouse Response:

Westinghouse has completely revised the AP1000 Spent Fuel Pool (SFP) criticality analysis in APP-GW-GLR-029, Revision 0 "Spent Fuel Storage Racks Criticality Analysis" (formerly Technical Report TR-65) with a new methodology that meets 10 CFR 50.68 requirements. The new analysis is APP-GW-GLR-029, Revision 1, entitled "AP1000 Spent Fuel Storage Racks Criticality Analysis" (Reference 1) which is a complete rewrite to supersede Revision 0. The revised analysis includes a detailed calculation package from a certified subcontractor (Reference 2) that was reviewed and approved through the Westinghouse quality program.

Key supporting documents (i.e. drawings, computer input decks) for this analysis will be submitted to the NRC under separate transmittals. The new methods and models replace specific shortcomings that the NRC identified as being no longer reliable as "approved methodology." These new efforts include evaluation of soluble boron, fuel assembly burn-up, and various design and operational parameters to properly credit reactivity for the Region 2 spent fuel racks. Finally, the revision to the analysis presents a new and thorough methodology focused on the AP1000 design that fully incorporates current and emerging industry and regulatory guidance that is specifically designed to meet NRC and industry objectives to comply with 10 CFR 50.68 requirements.

Specific to the requested new methodology, Westinghouse and our certified subcontractor (Holtec International) have interacted with industry professionals from the Nuclear Energy Institute (NEI) and NRC through several meetings, workshops, and phone calls since August 2008. The discussions focused in part on developing robust and bounding SFP criticality analysis inputs and variables that fully encompass the operational, safety, and regulatory compliance demands of the AP1000 technology.

Finally, the new methodology outlined above presents a plant-specific criticality calculation for spent fuel pool configurations that includes technically supported margins and a new soluble boron credit methodology. Such calculations were required and requested by NRC letter (ML012080337). The revised AP1000 DCD and new criticality analysis outlined above neither use nor reference the old analysis or the NRC acceptance letter (formerly DCD Section 4.3.5, References, Reference 63) that described use and applicability of Topical Report WCAP-14416-P, "Westinghouse Spent Fuel Rack Criticality Analysis Methodology," June 1995 of the old analysis. These references have been removed from the AP1000 DCD and new criticality analysis.

This response is expected to serve as the response to RAI-SRP4.3-SRSB-03. In addition, Westinghouse requests that this RAI response be accepted to close the similarly worded draft OI from the Chapter 4 SER, numbered as OI-SRP9.1.1-SRSB-01.

The required changes to DCD Rev. 17 sections that support the new SFP criticality analysis are summarized below and attached to this RAI.

Reference(s):

1) APP-GW-GLR-029, "AP1000 Spent Fuel Storage Racks Criticality Analysis", Revision 1
2) Holtec International Calculation Package No. HI-2094327, Revision 0

Design Control Document (DCD) Revision:

The following summary list of DCD changes is required to support the results of the revised SFP criticality analysis. The actual changes to each section are attached below.

DCD Section	Title	DCD Page
4.3.2.6.1	Criticality Design Method Outside the Reactor	pg. 4.3-29
4.3.2.6.2	Soluble Boron Credit Methodology	pg. 4.3-30
4.3.5	References	pg. 4.3-39
9.1.2.1	Design Bases	pg. 9.1-5
9.1.2.3	Safety Evaluation	pg. 9.1-11
9.1.7	References	pg. 9.1-50

16 Tech Spec LCO/SR	3.7.12, Spent Fuel Pool Storage	pg. 3.7.12-1
16 Tech Spec Des. Features	4.3, Fuel Storage	pg. 4.0-2
16 Tech Spec SL Bases	B 3.7.11, Fuel Storage Pool Boron Concentration	pg. B 3.7.11-1
16 Tech Spec SL Bases	B 3.7.12, Spent Fuel Pool Storage	pg. B 3.7.12-1

PRA Revision:
None.

Technical Report (TR) Revision:
Westinghouse document APP-GW-GLR-029, Revision 0 (previously submitted to the NRC as Technical Report TR-65) is completely revised in its entirety and replaced by Westinghouse document APP-GW-GLR-029, Revision 1. This is completed and available for review and confirmatory audit. It will be provided as a separate docketed transmittal to the NRC along with necessary supporting documents.

<u>The following changes are made to Section 4.3 of DCD (Rev. 17):</u>

4.3.2.6.1 Criticality Design Method Outside the Reactor

Criticality of fuel assemblies outside the reactor is precluded by adequate design of fuel transfer, shipping, and storage facilities and by administrative control procedures. The two principal methods of preventing criticality are limiting the fuel assembly array size and limiting assembly interaction by fixing the minimum separation between assemblies and/or inserting neutron poisons between assemblies.

The design criteria are consistent with General Design Criterion (GDC) 62, Reference 19, and NRC guidance given in Reference 20. The applicable 10 CFR Part 50.68 requirements are as follows:

1. The maximum K-effective value, including all biases and uncertainties, must be less than 0.95 with soluble boron credit and less than 1.0 with full density unborated water. Note this design criterion is provided in 10 CFR Part 50.68, Item 4 of Paragraph b. Note that the specific terminology is:

   "If no credit for soluble boron is taken, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with unborated water. If credit is taken for soluble boron, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water."

2. The maximum enrichment of fresh fuel assemblies must be less than or equal to 5.0 weight-percent U-235. Note this design criterion is provided in 10 CFR Part 50.68, Item 7 of Paragraph b. Note that the specific terminology is:

   "The maximum nominal U–235 enrichment of the fresh fuel assemblies is limited to five (5.0) percent by weight."

The following conditions are assumed in meeting this design bases:

- The fuel assembly contains the highest enrichment authorized without any control rods or non-integral burnable absorber(s) and is at its most reactive point in life.
- For flooded conditions, the moderator is pure water at the temperature within the design limits which yields the largest reactivity.
- The array is either infinite in lateral extent or is surrounded by a conservatively chosen reflector, whichever is appropriate for the design.
- Mechanical uncertainties are treated ~~either by using worst-case conditions or by performing sensitivity studies and obtaining appropriate uncertainties.~~ by combining both the worst-case bounding value and sensitivity study approaches.
- Credit is taken for the neutron absorption in structural materials and in solid materials added specifically for neutron absorption.

Fuel depletion analyses during core operation were performed with CASMO-4 (using the 70-group cross-section library), a two-dimensional multigroup transport theory code based on capture probabilities (Reference 53). CASMO-4 is used to determine the isotopic composition of the spent fuel. In addition, the CASMO-4 calculations are restarted in the storage rack geometry, yielding the two-dimensional infinite multiplication factor (k_{inf}) for the storage rack to determine the reactivity effect of fuel and rack tolerances, temperature variation, and to perform various studies.

The design method which determines the criticality safety of fuel assemblies outside the reactor uses the ~~SCALE 4.4a system~~ MCNP4a code (Reference 21), ~~which includes the BONAMI and NITAWL-II codes for cross sections generation and the KENO-V.a code for reactivity determination.~~ with continuous energy cross-sections based on ENDF/B-V and ENDF/B-VI.

~~The 238 group library obtained from ENDF/B-V data is the origin of the 44 group library used in these analyses and in the modeling of the critical experiments, which are the basis for the qualification of the SCALE/KENO-V.a (Reference 26) calculation system.~~

A set of ~~30~~ 62 critical experiments has been analyzed using the above method to demonstrate its applicability to criticality analysis and to establish the method bias and uncertainty. The benchmark experiments cover a wide range of geometries, materials, and enrichments, all of them adequate for qualifying methods to analyze light water reactor lattices (References 22 to ~~25~~ 28, and ~~27~~ 65 to 68).

The analysis of the ~~30~~ 62 critical experiments results in an average Keff of ~~0.9969~~ 0.9991. Comparison with the measured values results in a method bias of ~~0.0031~~ 0.0009. The standard deviation of the set of reactivities is ~~0.00285~~ 0.0011. The 95/95 tolerance factor is ~~2.22~~ conservatively set to 2.0.

The analytical methods employed herein conform with ANSI N18.2 (Reference 3), Section 5.7, Fuel Handling System; ANSI N16.9 (Reference 29), NRC Standard Review Plan, subsection 9.1.2, the NRC guidance, "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications" (Reference 30).

4.3.2.6.2 Soluble Boron Credit Methodology

~~The methodology used in this analysis for soluble boron credit is analogous to that of Reference 62, and it uses analysis criteria consistent with those cited in the Safety Evaluation by the Office of Nuclear Reactor Regulation (Reference 63). Reference 62 was reviewed and approved by the NRC. The methodology used in this analysis and in Reference 62 uses axially distributed burnups to represent discharged fuel assemblies.~~

The minimum soluble boron requirement under normal and accident conditions must be determined to show that the reactivity of the spent fuel racks remains below 0.95. This is achieved by crediting a discrete amount of soluble boron and then determining by linear interpolation the appropriate amount of soluble boron necessary to reduce the maximum Keff to 0.95 with all uncertainties and biases included.

~~A brief summary of the analysis approach and criteria follows:~~

- ~~Determine the fresh and spent fuel storage configurations using no soluble boron conditions so that the 95/95 upper tolerance limit value of Keff, including applicable biases and uncertainties, is less than 0.995. This is accomplished with infinite arrays of either fresh or spent fuel assembly configurations. Note that the actual NRC Keff limit for this condition is unity. Therefore, an additional margin of 0.005 ΔKeff units is included in the analysis results.~~

- ~~Determine the amount (ppm) of soluble boron necessary to reduce the Keff value of all storage configurations by at least 0.05 ΔKeff units. This is accomplished by constructing a KENO model for the entire spent fuel pool, which includes the storage configurations that are least sensitive to changes in soluble boron concentration. As an example, storage configurations that contain depleted fuel assemblies (and represented by depleted isotopics) are less reactivity-sensitive to changes in soluble boron concentration than a fuel assembly represented by zero burnup and relatively low initial fuel enrichment.~~

- ~~Determine the amount of soluble boron necessary to compensate for 5 percent of the maximum burnup credited in any storage configuration. In addition, determine the amount of soluble boron necessary to account for a reactivity depletion uncertainty of 1.0% ΔKeff per 30,000 MWD/MTU of credited fuel burnup. This is accomplished by multiplying this derivative by the maximum burnup credited in any storage configuration and converting to soluble boron using the data generated in Step 2.~~

- ~~Determine the largest increase in reactivity caused by postulated accidents and the corresponding amount of soluble boron needed to offset this reactivity increase.~~

~~The final soluble boron credit (SBC) requirement is determined from the following summation:~~

~~SBCTOTAL = SBC95/95 + SBCRE + SBCPA~~

~~Where,~~

~~SBCTOTAL = total soluble boron credit requirement (ppm).~~

~~SBC95/95 = soluble boron requirement for 95/95 Keff less than or equal to 0.95.~~

~~SBCRE = soluble boron required to account for burnup and reactivity uncertainties.~~

~~SBCPA = soluble boron required to offset accident conditions.~~

~~For the analyses, minimum burnup limits established for fuel assemblies to be stored in the storage configurations racks include burnup credit established in a manner that takes into account approximations to the operating history of the fuel assemblies. Variables such as the axial burnup profile as well as the axial profile of moderator and fuel temperatures have been factored into the analyses.~~

4.3.5 References

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The following changes are made to Section 9.1 of DCD (Rev. 17):

Make the following change to **Section 9.1.2.1, Design Bases**, (second paragraph):

The design of the spent fuel racks is such that a fuel assembly cannot be inserted into a location (i.e. between racks) other than a location designed to receive an assembly. Insertion of a fuel assembly into a fuel pool (vs. rack) location not designed to receive it (i.e. tool storage area, adjacent to the defective fuel cells and wall) is prevented administratively and addressed in Section 9.1.2.3.~~An assembly cannot be inserted into a full location.~~

Make the following change to **Section 9.1.2.3, Safety Evaluation**, (second paragraph):

The design of the racks is such that Keff remains less than or equal to 0.95 under design basis conditions, including fuel handling accidents. Inadvertent insertion of a fuel assembly between the rack periphery and the pool wall or placement of a fuel assembly across the top of a fuel rack is considered a postulated accident, and as such, realistic initial conditions such as boron in the pool water are assumed. These accident conditions have an acceptable Keff of less than 0.95. The criticality evaluation, which meets the requirements of 10 CFR 50.68, Paragraph b (Reference 21), considers the inherent neutron absorbing effect of the materials of construction, including fixed neutron absorbing "poison" material. Soluble boron in the spent fuel pool ~~plutonium decay time, integral fuel burnable absorber,~~ and assembly burnup are used as reactivity credits.

Make the following change to **Section 9.1.7, References**, (Ref. #20)

20. APP-GW-GLR-029, Revision 1, "AP1000 Spent Fuel Storage Racks Criticality Analysis," Westinghouse Electric Company LLC.

The following changes are made to Tech Spec LCO 3.7.12 of DCD (Rev. 17):

3.7.12 Spent Fuel Pool Storage

LCO 3.7.12 The combination of initial enrichment and burnup of each fuel assembly stored in Region 2 shall be within the limits specified in Figure 3.7.12-1. ~~or~~

~~The combination of initial enrichment, burnup, and decay time of each fuel assembly stored in Region 2 in the Spent Fuel (1.361 w/o) locations in a "1-out-of-4 5.0 weight percent fresh" configuration shall be within the limits specified in Figures 3.7.12-2.~~

~~Fuel may be stored in Region 2 in both "All Cell" and "1-out-of-4 5.0 weight-percent fresh" storage configurations together, provided the~~

~~fuel stored in the interface locations surrounding the "1-out-of-4 5.0 weight-percent fresh" group(s) meet the initial enrichment, burnup, and decay time limits specified in Figure 3.7.12-2.~~

APPLICABILITY: Whenever any fuel assembly is stored in Region 2 of the spent fuel storage pool.

ACTIONS

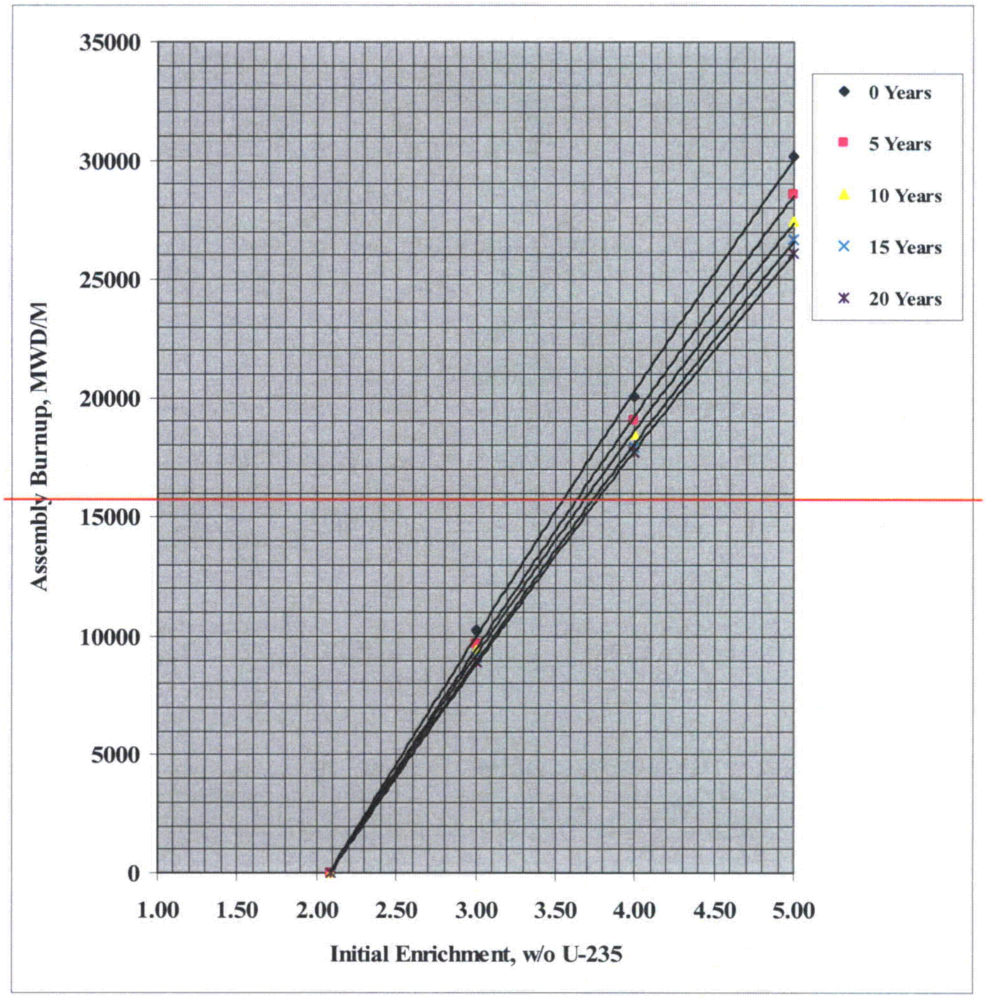
- NOTE -

LCOs 3.0.3 and 3.0.8 are not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Requirements of the LCO not met.	A.1 Initiate action to move the noncomplying fuel assembly to Region 1.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.12.1	Verify by administrative means the initial enrichment~~,~~ and burnup~~, and decay time~~ of the fuel assembly is in accordance with Figure~~s~~ 3.7.12-1~~ or 3.7.12-2, as applicable for "All Cell," "1-out-of-4 5.0 weight-percent fresh" and interface spent fuel assembly storage configurations.~~	Prior to storing the fuel assembly in Region 2



~~Figure 3.7.12-1~~
~~Minimum Fuel Assembly Burnup Versus Initial Enrichment for the Region 2 "All Cell" Storage Configurations~~

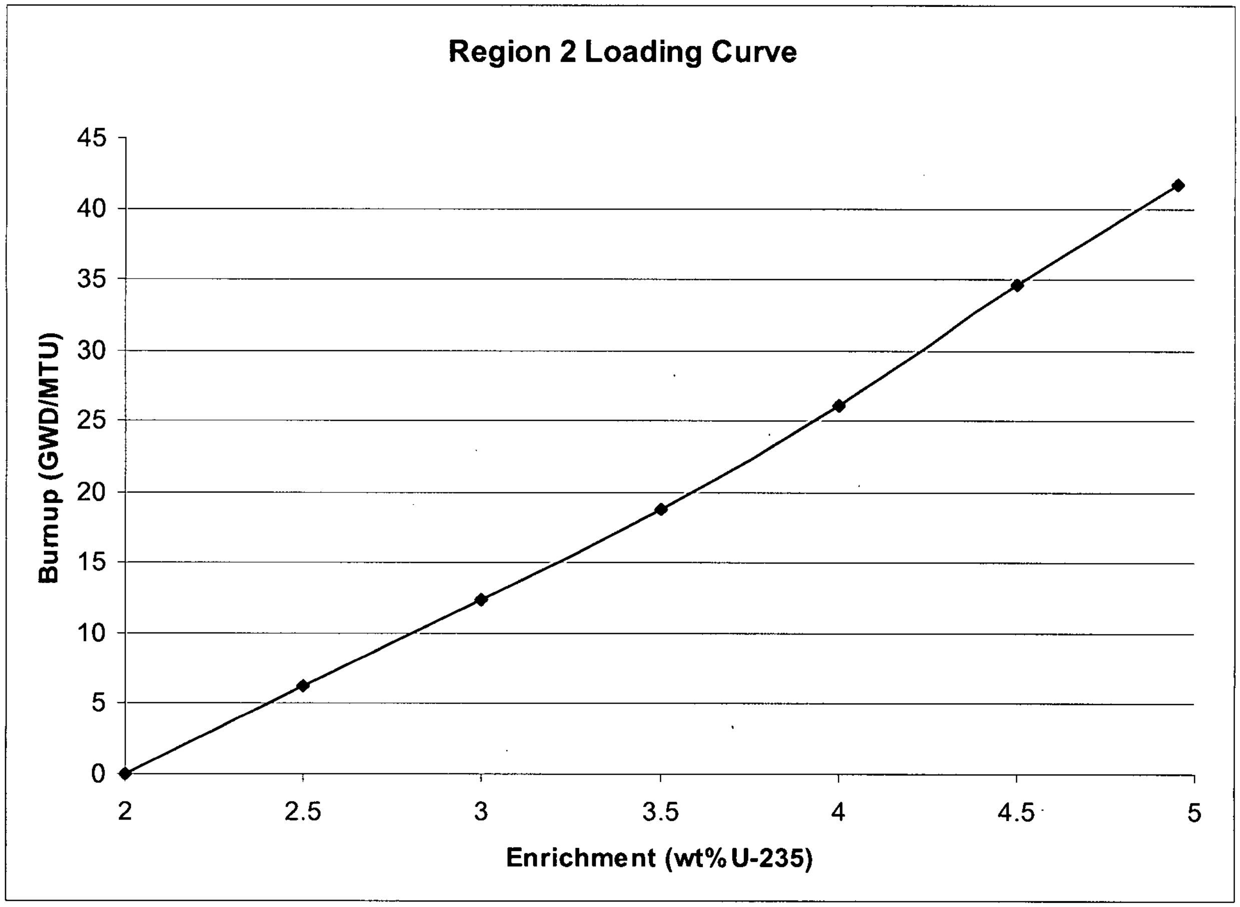
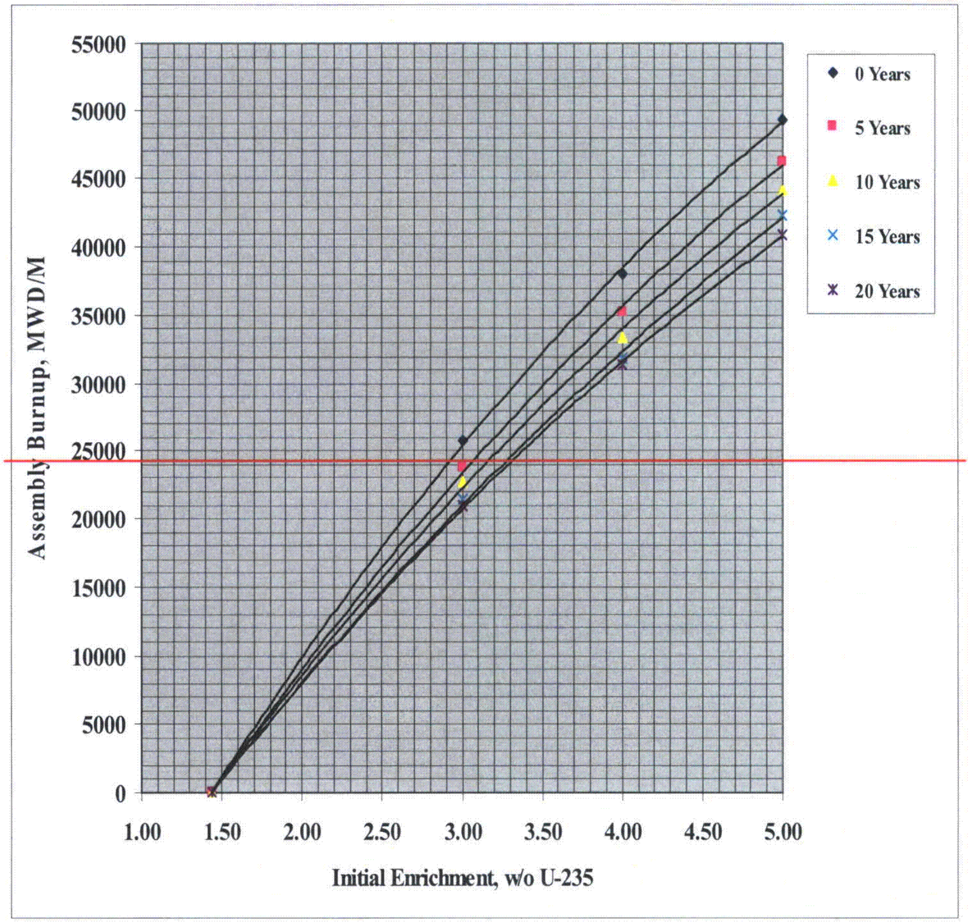


Figure 3.7.12-1

Minimum Fuel Assembly Burnup Versus Initial Enrichment for ~~the~~ Region 2 ~~"All Cell" Storage Configurations~~<u>Spent Fuel Cells</u>



~~Figure 3.7.12-2~~

~~Minimum Fuel Assembly Burnup Versus Initial Enrichment for the Region 2 "1-out-of-4 5.0 Weight-Percent Fresh" Storage Configurations~~

<u>The following changes are made to Tech Spec Design Features 4.3 of DCD (Rev. 17):</u>

4.3 Fuel Storage

4.3.1 <u>Criticality</u>

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

a. Fuel assemblies having a maximum U-235 enrichment of 5.0 weight percent.

b. $k_{eff} \leq 0.95$ if fully flooded with unborated water which includes an allowance for uncertainties as described in Section 9.1, "Fuel Storage and Handling."

c. A nominal 10.90 inch center-to-center distance between fuel assemblies placed in Region 1, a nominal 9.028 inch center-to-center distance between fuel assemblies placed in Region 2 of the spent fuel storage racks, and a nominal 11.62 inch center-to-center distance between fuel assemblies placed in the Defective Fuel Cells.

d. New or partially spent fuel assemblies with any discharge burnup may be allowed unrestricted storage in Region 1 and the Defective Fuel Cells of Figure 4.3-1;

e. Partially spent fuel assemblies meeting the initial enrichment and burnup requirements of LCO 3.7.12, "Spent Fuel Pool Storage," may be stored in Region 2 of Figure 4.3-1.

~~f. New and spent fuel assemblies meeting the Figure 4.3-2 location-specific initial enrichment, burnup, and decay time requirements of LCO 3.7.12, "Spent Fuel Pool Storage," may be stored in specified Region 2 locations.~~

4.3.1.2 The new fuel storage racks are designed and shall be maintained with:

a. Fuel assemblies having a maximum U-235 enrichment of 5.0 weight percent.

b. $k_{eff} \leq 0.95$ if fully flooded with unborated water which includes an allowance for uncertainties as described in Section 9.1, "Fuel Storage and Handling."

c. $k_{eff} \leq 0.98$ if moderated by aqueous foam which includes an allowance for uncertainties as described in Section 9.1, "Fuel Storage and Handling."

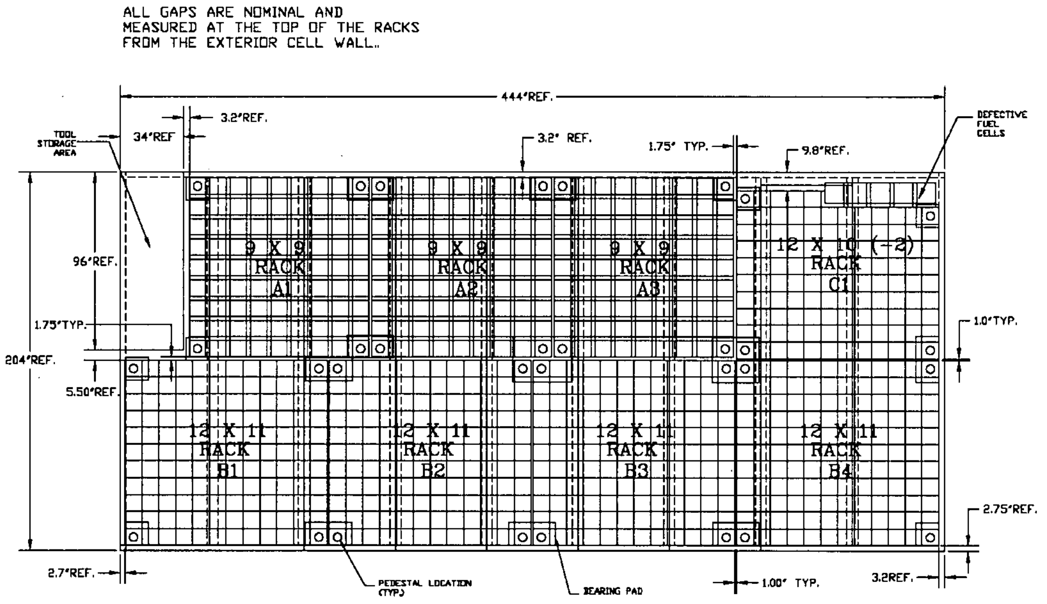
d. A nominal 10.90 inch center-to-center distance between fuel assemblies placed in the new fuel storage racks.

4.3.2 Drainage

The spent fuel pool is designed and shall be maintained to prevent inadvertent draining of the pool below a minimum water depth of ≥23 ft above the surface of the fuel storage racks.

4.3.3 Capacity

The spent fuel pool is designed and shall be maintained with a storage capacity limited to no more than 889 fuel assemblies.



Region 1 (A1, A2, A3) – 243 locations
Region 2 (B1, B2, B3, B4, C1) – 641 locations
Defective Fuel Cells (DFCs) – 5 locations
Total Storage Locations – 889 ~~Locations~~

Figure 4.3-1

Discrete Two Region Spent Fuel Pool Rack Layout

~~Spent Fuel (equivalent to 1.361 w/o fresh fuel)~~	~~New Fuel (5.0 w/o fresh fuel and all spent fuel)~~
~~Spent Fuel (equivalent to 1.361 w/o fresh fuel)~~	~~Spent Fuel (equivalent to 1.361 w/o fresh fuel)~~

~~Figure 4.3-2~~

~~Region 2 "1-out-of-4 5.0 Weight-Percent Fresh" Fuel Configuration~~

The following changes are made to Tech Spec Bases 3.7.11 of DCD (Rev. 17):

B 3.7.11 Fuel Storage Pool Boron Concentration

BASES

BACKGROUND

The water in the spent fuel storage pool normally contains soluble boron, which would result in large subcriticality margins under actual operating conditions. For storage of fuel in the spent fuel racks, the design basis for preventing criticality outside the reactor is that there is a 95 percent probability at a 95 percent confidence level, without soluble boron, that the effective multiplication factor (k_{eff}) of the fuel assembly array will be less than 0.995, including uncertainties and tolerances. The NRC guidelines specify a limiting k_{eff} of 1.0 for normal storage in the absence of soluble boron. ~~Hence~~Therefore, the design is based on the use of unborated water, which maintains a subcritical condition ~~for the allowed loading patterns~~ (Ref. 1). The double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 2) allows credit for soluble boron under other abnormal or accident conditions, since only a single independent accident need be considered at one time. For example, the only accident scenario that has a potential for more than negligible positive reactivity effect is an inadvertent misplacement of a new fuel assembly. This accident has the potential for exceeding the limiting reactivity, should there be a concurrent and independent accident condition resulting in the loss of all soluble poison. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. Safe operation with unborated water and no movement of assemblies may, therefore, be achieved by controlling the location of each assembly in accordance with LCO 3.7.12, "Spent Fuel Pool Storage." Prior to movement of an assembly, it is necessary to perform SR 3.7.12.1.

APPLICABLE SAFETY ANALYSES

Although credit for the soluble boron normally present in the spent fuel pool water is permitted under abnormal or accident conditions, most abnormal or accident conditions will not result in exceeding the limiting reactivity even in the absence of soluble boron. The effects on reactivity of credible abnormal and accident conditions due to temperature increase, ~~boiling,~~ assembly dropped on top of a rack, ~~lateral rack module movement~~ and misplacement/misloading of a fuel assembly have been analyzed. The reactivity effects of bulk spent fuel pool temperature increase (>140°F) and steaming from the pool water surface or intramodule water gap reductions between the firmly interconnected cell and module arrays due to a seismic event are bounded by the fuel mishandling/misloading reactivity increases and therefore assessed as negligible. The spent fuel pool k_{eff} storage limit of 0.95 is maintained during these events by a minimum boron concentration of ~~758~~ greater than or equal to 750 ppm established by ~~critically~~ criticality analysis (Ref. 3). Compliance with the LCO minimum boron concentration limit of 2300 ppm ensures that the credited concentration is always available.
The concentration of dissolved boron in the fuel storage pool satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

BASES

LCO

The fuel storage pool boron concentration is required to be ≥2300 ppm. The specified concentration of dissolved boron in the fuel storage pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in References 1 and 3. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the fuel storage pool.

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the spent fuel storage pool and a fuel storage pool verification has not been performed since the last movement of fuel assemblies in the fuel storage pool.

ACTIONS	LCO 3.0.3 is applicable while in MODE 1, 2, 3, or 4. Since spent fuel pool cooling requirements apply in all MODES when fuel is stored in the spent fuel storage pool, the ACTIONS have been modified by the Note stating that LCO 3.0.3 is not applicable. Spent fuel pool boron concentration requirements are independent of reactor operations. Entering LCO 3.0.3 while in MODE 1, 2, 3, or 4 would require the unit to be shutdown unnecessarily. LCO 3.0.8 is applicable while in MODE 5 or 6. Since spent fuel pool cooling requirements apply in all MODES when fuel is stored in the spent fuel storage pool, the ACTIONS have been modified by a Note stating that LCO 3.0.8 is not applicable. Spent fuel pool boron concentration requirements are independent of shutdown reactor operations. Entering LCO 3.0.8 while in MODE 5 or 6 would require the optimization of plant safety, unnecessarily. A.1, A.2.1, and A.2.2 When the concentration of boron in the fuel storage pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored simultaneously with suspending movement of fuel assemblies. An acceptable alternative is to verify by administrative means that the fuel storage pool verification has been performed since the last movement of fuel assemblies in the fuel storage pool. However, prior to resuming movement of fuel assemblies, the concentration of boron must be restored. This does not preclude movement of a fuel assembly to a safe position.
SURVEILLANCE REQUIREMENTS	SR 3.7.11.1 This SR verifies that the concentration of boron in the fuel storage pool is within the required limit. As long as this SR is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no major replenishment of pool water is expected to take place over such a short period of time.
REFERENCES	1. AP1000 Design Control Document, ~~Rev. 15~~ Section 9.1.2, "Spent Fuel Storage" and 15.7.4, "Fuel Handling Accident." 2. Double contingency principle of ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed

revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).

3. APP-GW-GLR-029, Revision 1, "AP1000 Spent Fuel Storage Racks Critically Analysis~~,~~" ~~June 2006~~.

The following changes are made to Tech Spec Bases 3.7.12 of DCD (Rev. 17):

B 3.7.12 Spent Fuel Pool Storage

BASES

BACKGROUND

The high density spent fuel storage racks are divided into two separate and distinct regions and include locations for storage of defective fuel as shown in Figure 4.3-1. Region 1, with a maximum of 243 storage locations and the Defective Fuel Cells, with 5 storage locations are designed to accommodate new fuel assemblies with a maximum enrichment of 5.0 weight percent U-235, or spent fuel assemblies regardless of the combination of initial enrichment~~,~~ and burnup~~, and decay time~~. Region 2, with a maximum of 641 storage locations is designed to accommodate spent fuel assemblies in all locations which comply with the combination of initial enrichment~~,~~ and burnup ~~and decay time limits~~ specified in LCO Figure 3.7.12-1, Minimum Fuel Assembly Burnup Requirements for ~~the~~ Region 2 Spent fuel Cells. ~~, "All Cell" Storage Configuration.~~ Use of the IFE fuel rod storage canister is subject to the same storage requirements as the fuel assemblies. ~~Additionally, a second scheme "1-out-of-4 5.0 weight-percent fresh" is available for Region 2 as shown in Figure 4.3-2. New 5.0 weight percent U-235 fuel or any spent fuel may be stored in one location. Spent fuel (equivalent to 1.361 new fuel) shall be stored in the other three locations. The combination of initial enrichment, burnup, and decay time of the three spent fuel assemblies shall comply with the limits specified in LCO Figure 3.7.12-2, Fuel Assembly Burnup Requirements for the Region 2 "1-out-of-4 5.0 weight-percent fresh" Storage Configuration. The set of four relative storage locations may be repeated throughout Region 2. If the "1-out-of-4 5.0 weight-percent fresh" and the "All Cell" configurations are used together, the fuel in the storage locations surrounding the "1-out-of-4 5.0 weight-percent fresh" group(s) shall meet the LCO 3.7.12, Figure 3.7.12-2 limits.~~
The water in the spent fuel storage pool normally contains soluble boron, which would result in large subcriticality margins under actual operating

conditions. For storage of fuel in the spent fuel racks, the design basis for preventing criticality outside the reactor is that there is a 95 percent probability at a 95 percent confidence level, without soluble boron, that the effective multiplication faction (k_{eff}) of the fuel assembly array will be less than 0.995, including uncertainties and tolerances. The NRC guidelines specify a limiting k_{eff} of 1.0 for normal storage in the absence of soluble boron. Hence, the design is based on the use of unborated water, which maintains a subcritical condition for the allowed loading pattern.

The double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 1) allows credit for soluble boron under other abnormal and accident conditions, since only a single independent accident need be considered at one time. For example, the only accident scenario that has an inadvertent misplacement of a new fuel assembly. This accident has the potential for more than negligible positive reactivity effect is a potential for exceeding the limiting reactivity, should there be a concurrent and independent accident condition resulting in the loss of all soluble poison. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. Safe operation with unborated water and no movement of assemblies may, therefore, be achieved by controlling the combination of initial enrichment~~,~~ and burnup ~~and decay time of the stored fuel~~ in accordance with the accompanying LCO. Prior to movement of an assembly, it is necessary to perform SR 3.7.12.1.

APPLICABLE SAFETY ANALYSES

The hypothetical accidents can only take place during or as a result of the movement of an assembly (Refs. 2 and 3). For these accident occurrences, the presence of soluble boron in the spent fuel storage pool (controlled by LCO 3.7.15, "Fuel Storage Pool Boron Concentration") prevents criticality. By closely controlling the movement of each assembly and by checking the location of each assembly after movement, the time period for potential accidents may be limited to a small fraction of the total operating time. During the remaining time period with no potential for accidents, the operation may be under the auspices of the accompanying LCO.

The configuration of fuel assemblies in the fuel storage pool satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The restrictions on the placement of fuel assemblies within Region 2 of the spent fuel pool in the accompanying LCO, ensure the k_{eff} of the spent fuel storage pool will always remain < 0.995, assuming the pool to be flooded with unborated water and < 0.95, with a boron concentration of greater than ~~758~~ or equal to 750 ppm.

~~"All Cell" Storage Configuration~~

~~The "All Cell" storage configuration~~ Region 2 permits storage ~~in all Region 2 locations~~ of spent fuel assemblies in any cell location provided the assembly ~~which~~ meets the combination of initial enrichment~~,~~ and burnup ~~and decay time requirements~~ shown in LCO Figure 3.7.12-1, Fuel Assembly Burnup Requirements for the Region 2 Spent Fuel Cells. ~~, "All Cell" Storage Requirements Configuration. Figure 3.7.12-1 permits new (no burnup) 1.627 weight percent U-235 fuel to be stored in the All Cell configuration. "1-out-of-4 5.0 weight-percent fresh" Storage Configuration Fuel stored in accordance with the "1-out-of-4 5.0 weight-percent fresh" storage configuration shall be stored in the relative locations shown in Figure 4.3-2. The "1-out-of-4 5.0 weight-percent fresh" storage configuration permits storage of 5.0 weight percent U-235 new (no burnup) fuel or any spent fuel in one specified location, provided fuel stored in the three remaining locations meets the enrichment, burnup and decay time requirements shown in LCO Figure 3.7.12-2, Fuel Assembly Burnup Requirements for the Region 2 "1-out-of-4 5.0 w/o Fresh" Storage Configuration. Figure 3.7.12-2 permits new (no burnup) 1.361 weight percent U-235 fuel to be stored in the three remaining locations. The 4-location configuration may be repeated throughout Region 2.~~

APPLICABILITY

This LCO applies whenever any fuel assembly is stored in Region 2 of this fuel storage pool.

ACTIONS

LCO 3.0.3 is applicable while in MODE 1, 2, 3, or 4. Since spent fuel pool storage requirements apply in all MODES when fuel is stored in Region 2 or 3, the ACTIONS have been modified by a Note stating the LCO 3.0.3 is not applicable. Spent fuel pool storage requirements are independent of reactor operations. Entering LCO 3.0.3 while in MODE 1, 2, 3, or 4 would require the unit to be shutdown unnecessarily.

LCO 3.0.8 is applicable while in MODE 5 or 6. Since spent fuel pool storage requirements apply in all MODES when fuel is stored in Region 2 or 3, the ACTIONS have been modified by a Note stating the LCO 3.0.8 is not applicable. Spent fuel pool storage requirements are independent of shutdown reactor operations. Entering LCO 3.0.8 while in MODE 5 or 6 would require the optimization of plant safety, unnecessarily.

BASES

A.1

The LCO is not met if spent fuel assemblies stored in Region 2 ~~"All Cell," "1-out-of-4 5.0 weight-percent fresh" or interface~~ spent fuel assembly storage locations do not meet the applicable initial enrichment~~,~~ and burnup ~~and decay time~~ limits in accordance with Figure 3.7.12-1. ~~or 3.7.12-2~~

When the LCO is not met, action must be initiated immediately to make the necessary fuel assembly movement(s) in Region 2 to bring the storage configuration into compliance with Figure 3.7.12-1 by moving the affected fuel assemblies to Region 1 or the Defective Fuel Cells.. ~~Additionally, LCO is not met if fuel, required to be stored in the New Fuel location of the "1-out-of-4 5.0 weight-percent fresh" storage configuration, is misplaced. When the LCO is not met, action must be initiated immediately to make the necessary fuel assembly movement(s) in Region 2 to bring the storage configuration into compliance with Figures 3.7.12-1 and 3.7.12-2 or to move fuel to Region 1 or the defective fuel cells.~~

SURVEILLANCE REQUIREMENTS

SR 3.7.12.1

This SR verifies by administrative means that the initial enrichment~~,~~ and burnup ~~and decay time~~ of the fuel assembly is in accordance with Figure 3.7.12-1. ~~or 3.7.12-2 as applicable for the "All Cell," "1-out-of-4 5.0 weight-percent fresh" and interface spent fuel assembly storage locations.~~ Fuel assemblies stored in Region 2 that do not meet the Figure 3.7.12-1 enrichment and burnup limits shall be stored in Region 1. ~~Fuel stored in Region 2 that does not meet the Figure 3.7.12-1 or 3.7.12-2 limits shall be stored in Figure 4.3-1 "1-out-of-4 5.0 weight-percent fresh" New Fuel location.~~

REFERENCES

1. Double contingency principle ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).

2. APP-GW-GLR-029, Revision 1, "AP1000 Spent Fuel Storage Racks Criticality Analysis.~~,~~" ~~June 2006~~.

3. AP1000 Design Control Document, Section 9.12, "Spent Fuel Storage" and 15.7.4, "Fuel Handling Accident."