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2CAN070503

July 21, 2005

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

SUBJECT: License Amendment Request
To Add Cask Loading Restrictions
Arkansas Nuclear One, Unit 2
Docket No. 50-368
License No. NPF-6

REFERENCES:
1. NRC Regulatory Issue Summary 2005-05, *Regulatory Issues Regarding Criticality Analyses for Spent Fuel Pools and Independent Spent Fuel Storage Installations*
2. Entergy letter to the NRC dated July 7, 2005, *Pre-Application Review for License Amendment Request Regarding ANO-2 Cask Loading Pit Criticality Analysis* (2CAN070502)

Dear Sir or Madam:

Pursuant to 10 CFR 50.90, Entergy Operations, Inc. (Entergy) hereby requests an amendment to the Technical Specifications (TS) for Arkansas Nuclear One, Unit 2 (ANO-2). The proposed change will modify TS 3.9.12, *Fuel Storage*, to define spent fuel loading restrictions for the Holtec International HI-STORM 100 Cask System Multi-Purpose Canister (MPC) -32. Entergy also proposes a change to the licensing bases for the SFP to include the methods, assumptions and results associated with the criticality analysis developed to support loading/unloading of an MPC-32.

The Nuclear Regulatory Commission (NRC) issued Regulatory Issue Summary (RIS) 2005-05, *Regulatory Issues Regarding Criticality Analyses for Spent Fuel Pools and Independent Spent Fuel Storage Installations,* on March 23, 2005. RIS 2005-05 highlighted differences in the NRC Part 50 criticality requirements for the spent fuel pool and Part 72 requirements for spent fuel storage casks and emphasized that licensees are expected to comply with both Part 50 and Part 72 during cask loading operations. This request results from Entergy's review of the RIS.

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Entergy submitted a pre-application review (Reference 2) to discuss the proposed change and provide a basis for continuing loading activities while NRC reviews the proposed change as a non-exigent request. While developing the proposed change, it was identified that the summary of the Part 50 and Part 72 boron concentrations that were included in the pre-application inappropriately reported the Part 72 boron concentration associated with Babcock & Wilcox (B&W) fuel rather than Combustion Engineering (CE) 16x16 fuel. The summary provided in Attachment 1 is corrected for CE fuel.

The proposed change has been evaluated in accordance with 10 CFR 50.91(a)(1) using criteria in 10 CFR 50.92(c) and it has been determined that this change involves no significant hazards consideration. The basis for this determination is included in the attached submittal.

The proposed change includes new commitments.

Entergy requests approval of this amendment by August 31, 2005, on an exigent basis in accordance with 10 CFR 50.91, paragraph (a)(6). This request meets the criteria of 10 CFR 50.91 (a)(6) because time does not permit the NRC to publish a *Federal Register* notice allowing 30 days for prior public comment and the requested amendment involves no significant hazards considerations. In accordance with 10 CFR 50.91(a)(6)(vi), the exigency could not be avoided by Entergy as further discussed in Attachment 1 of this submittal.

If you have any questions or require additional information, please contact Dana Millar at 601-368-5445.

I declare under penalty of perjury that the foregoing is true and correct. Executed on July 21, 2005.

Sincerely,

[signature] for Jeff Forbes

JSF/DM

Attachments:
1. Analysis of Proposed Technical Specification Changes
2. Proposed Technical Specification Changes (mark-up)
3. List of Regulatory Commitments

cc: Dr. Bruce S. Mallett
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Attachment 1

2CAN070503

Analysis of Proposed Technical Specification Changes

1.0 DESCRIPTION

This letter is a request to amend Operating License NPF-6 for Arkansas Nuclear One, Unit 2 (ANO-2).

The proposed change will revise the ANO-2 Technical Specifications (TS) associated with the spent fuel pool (SFP) to assure the regulatory requirements related to criticality in the SFP and applied to Holtec International's HI-STORM Multi-Purpose Canister (MPC-32) when it is in the SFP with the cask loading pit gate open are reflected in the ANO-2 TS. Following approval of the proposed change, changes will be made to the associated TS Bases and ANO-2 Safety Analysis Report (SAR) to reflect the association of the cask with the SFP criticality requirements.

Entergy requests approval of this amendment by August 31, 2005, on an exigent basis in accordance with 10 CFR 50.91, paragraph (a)(6). This request meets the criteria of 10 CFR 50.91 (a)(6) because time does not permit the NRC to publish a *Federal Register* notice allowing 30 days for prior public comment and the requested amendment involves no significant hazards considerations. In accordance with 10 CFR 50.91(a)(6)(vi), the exigency could not be avoided by Entergy.

Entergy believed that the calculation that considered the requirements of 10 CFR 50.68 for loading/unloading an MPC-32 met the criteria of 10 CFR 50.59 and 10 CFR 50.36 and did not require NRC review and approval. However, based on RIS 2005-05, Entergy submitted a pre-application letter to the NRC outlining the plans to submit a non-exigent TS change and justification for continued operations without prior NRC approval based on guidance contained in Administrative Letter 98-10 and Generic Letter 91-18. In a teleconference between Entergy and the NRC Staff held on July 19, 2005, the NRC stated that they did not believe ANO was in compliance with 10 CFR 50.68 and therefore the proposed change required NRC approval prior to proceeding with cask loading activities.

Currently, should it become necessary, the ANO-2 SFP does not contain enough space to allow a full core offload of fuel in the reactor core. Spent fuel assemblies must be relocated to dry cask storage to regain full core offload capability and to allow for the receipt of new fuel prior to the next ANO-2 refueling outage. An aggressive cask loading campaign has been initiated which is impacted by the need for the approval of the proposed TS change. Entergy could not have avoided the exigency due to the rapidly developing nature of this situation and its applicability to continue to move spent fuel for ANO-2.

Cask loading activities are scheduled to commence on or about September 6, 2005.

2.0 PROPOSED CHANGE

The proposed change to the ANO-2 TSs will modify TS 3.9.12. It has been determined by evaluation that the criticality analysis requirements for the SFP will be met when loading/unloading an MPC-32 in the SFP with the cask loading pit gate open only when loading restrictions are applied. Therefore, the following changes are proposed to ANO-2 TS:

- A new TS Limiting Condition for Operation (LCO) will be added, LCO 3.9.12.d, to identify that there are loading restrictions for the MPC-32 included in TS Figure 3.9-1.
- An additional loading restriction for the MPC-32 will be added as TS Figure 3.9-1.
- A note will be added to the applicability stating that the cask loading pit and tilt pit are considered part of the SFP when their associated gates are open.
- SR 4.9.12.d will be added to verify that fuel assemblies are placed in a storage cask within the limits of Figure 3.9-1 by checking the assemblies' design and burnup documentation.

In summary, the ANO-2 TSs will be modified to govern the fuel loading restrictions related to the Holtec HI-STORM 100 MPC-32. Following approval of the proposed change, Entergy will make changes to the ANO-2 SAR and the ANO-2 TS Bases to appropriately reflect the criticality analysis that was performed for the MPC-32.

3.0 BACKGROUND

<u>NRC Regulatory Issue Summary (RIS) 2005-05</u>

NRC RIS 2005-05, *Regulatory Issues Regarding Criticality Analyses for Spent Fuel Pools and Independent Spent Fuel Storage Installations,* describes a concern that when loading, unloading or handling a dry cask in the SFP, the requirements of 10 CFR 50.68, *Criticality accident requirements*, should be met. The RIS notes that the requirements associated with preventing SFP criticality are included in General Design Criteria (GDC) 62, *Prevention of criticality in fuel storage and handling* and 10 CFR 50.68, *Criticality accident requirements.* Requirements associated with detection of SFP criticality events are described in 10 CFR 70.24, *Criticality accident requirements.* The RIS also highlighted the differences in the NRC Part 50 criticality requirements for the SFP and the Part 72 requirements for the spent fuel storage casks and emphasized that licensees are expected to comply with both Part 50 and Part 72 during cask loading and unloading operations.

<u>ANO-2 Spent Fuel Pool Storage</u>

The ANO-2 SFP racks are designed to assure that when fuel assemblies of less than or equal to 4.55 ± 0.05 weight percent (wt%) Uranium-235 (U-235) are stored within the limits of TS Figure 3.9-2, a subcritical array with the effective neutron multiplication factor (k_{eff}) of less than or equal to 0.95 will be maintained when a concentration of 240 parts per million (ppm) of soluble boron is present in the SFP water.

The SFP contains racks that have the capacity of storing 988 spent fuel assemblies. Control components, which have been removed from the reactor core, may be stored in the spent fuel assemblies. In addition, new fuel may be stored in the SFP.

Adjacent to the SFP are two smaller pools. One pool contains the fuel transfer mechanism; the other pool is a loading area for the spent fuel shipping cask. These two pools are connected to the main pool by short water channels and may be isolated from the spent fuel pool by gates. These smaller pools may be pumped down to allow dry handling of spent fuel shipping cask, maintenance of the fuel transfer mechanism, etc.

The ANO-2 SFP is described in detail in Section 9.1.2 of the ANO-2 SAR.

ANO-2 TSs for the SFP

The following ANO-2 TSs are related to spent fuel storage or rack criticality.

- TS 3.9.12.a limits fuel enrichment for fuel assemblies stored in the SFP to 4.55 ± 0.5 wt% U-235.
- TS 3.9.12.b limits fuel storage in the SFP to designated patterns defined in Figure 3.9-2.
- TS 3.9.12.c specifies that boron concentration shall be greater than 2000 ppm in the ANO-2 SFP during storage of fuel in the SFP.
- TS 5.3.1 includes the description of the criticality requirements associated with the design of the spent fuel storage racks.

When the cask pit gate is open to the SFP these TSs apply to the fuel stored in the cask.

SFP Criticality Analysis

The objective of the SFP criticality analysis was to ensure that k_{eff} is less than or equal to 0.95 with the storage rack fully loaded with fuel of the highest permissible reactivity and the pool flooded with borated water at a temperature corresponding to the highest reactivity. In addition, the analysis demonstrated that k_{eff} is less than 1.0 under the assumed accident of the loss of soluble boron in the SFP water. The maximum calculated reactivities include a margin for uncertainty in reactivity calculations, including manufacturing tolerances, and are calculated with a 95% probability at a 95% confidence level.

Criticality of fuel assemblies in the SFP storage racks is prevented by the design of the rack which limits fuel assembly interaction, and by limiting fuel storage to five allowable loading patterns defined in TS Figure 3.9-2. The loading patterns are based on initial enrichment, burnup, cooling time, and the presence of control element assemblies (CEAs) in selected fuel assemblies. During normal conditions a credit of 240 ppm of soluble boron is required in the SFP water to ensure k_{eff} is maintained less than or equal to 0.95.

ANO-2 Spent Fuel Storage Accident Analysis

When performing the analysis for postulated accidents in the SFP, the double contingency principle of ANS N16.1-1975 was applied. This states that it is unnecessary to assume two unlikely, independent, concurrent events to ensure protection against a criticality accident. Therefore, for accident conditions, the presence of soluble boron in the SFP water can be assumed as a realistic initial condition since its absence would be a second unlikely event.

Table 1 provides the analytical results for the boron concentration that is required to ensure k_{eff} remains below 0.95 for the credible accidents. As required, in all cases the minimum boron concentration (2000 ppm) required by ANO-2 TS 3.9.12.c bounds the analytically determined soluble boron concentration required to assure k_{eff} is maintained less than or equal to 0.95.

Table 1
ANO-2 SFP Rack Accident Analysis Boron Requirements

Accident Evaluated	ANO-2 SFP Boron Concentration (ppm) required to assure $k_{eff} \leq 0.95$
Dropped fuel assembly	825
Misloading Accident	825
Misalignment of Active Fuel Region	2000

ANO-2 Dry Cask Storage

The SFP is designed with a spent fuel shipping cask pool that is hydraulically coupled to the SFP through a short water channel or transfer canal. The pool can be isolated from the SFP with the installation of a gate. By letter (Reference 1) to the NRC, Entergy submitted a request to increase the heavy loads limits associated with the ANO spent fuel crane. The NRC approved (Reference 2) the use of the upgraded L-3 crane for below-the-hook loads up to 130 tons, which is the design capacity of the new single-failure-proof crane. These letters (References 1 and 2) also included the recognition that when the gate is closed between the spent fuel shipping cask pool and the SFP, the spent fuel shipping cask pool is no longer consider part of the SFP.

Spent fuel cannot be stored in the transfer canal or in the cask storage area. Spent fuel is only moved into the vicinity of the MPC for the purpose of loading the spent fuel in the MPC.

Three dry cask storage designs are used at ANO-2; the Pacific Sierra Nuclear Associates' Ventilated Storage Cask (VSC-24), the Holtec International's HI-STORM 100 Cask MPC-24, and the HI-STORM MPC-32. The casks are described in their associated SAR, Certificate of Compliance (CoC), the ANO site specific storage cask specifications, drawings, and engineering documents. The HI-STORM MPC-32 is the primary cask used to store ANO-2 fuel assemblies.

4.0 TECHNICAL ANALYSIS

A criticality analysis was performed to ensure that k_{eff} is less than or equal to 0.95 with an MPC-32 cask fully loaded with fuel of the highest permissible reactivity. For normal conditions, the MPC-32 was analyzed with no credit for boron, and for accident conditions, credit for soluble boron was permitted. It was conservatively assumed that the initial U-235 fuel enrichment was 4.95 wt% with a tolerance of 0.05 wt%. The use of this enrichment and tolerance in the analyses of the normal storage and accident cases bounds the current allowable fuel enrichment for fuel assemblies stored in the SFP of 4.55 ± 0.5 wt% (TS 3.9.12.a and 5.3.2.a). The maximum calculated reactivity values included a margin for uncertainty in reactivity calculations, manufacturing tolerances, and temperature effects, and were calculated with a 95% probability at a 95% confidence level.

The Combustion Engineering (CE) 16 x 16 fuel assembly is the only fuel type used at ANO-2. The design specifications for the CE fuel assemblies, as used in the analysis, are provided in Table 2:

Table 2
Fuel Assembly Specifications

Assembly Data	
Rod Array Size	16 x 16
Rod Pitch (inches)	0.506
Total Length (inches)	176.803
Active Fuel Length (inches)	150
Fuel Rod Data	
Total Number of Fueled Rods	236
Fuel Rod Outer Diameter (inches)	0.382
Fuel Rod Inner Diameter (inches)	0.332
Cladding Thickness (inches)	0.025
Cladding Material	Zircaloy
Pellet Diameter (inches)	0.3255
UO_2 Stack Density (gm/cc)	10.522
Guide Tube Data	
Number of Tubes	5
Tube Outer Diameter (inches)	0.980
Tube Thickness (inches)	0.040
Tube Material	Zircaloy

A slightly larger than nominal pellet diameter was modeled in the criticality analyses to account for any pellet uncertainties.

CASK CRITICALITY ANALYTICAL METHODOLOGY

The principle methods for the criticality analysis for loading/unloading the cask in the SFP were performed using the following NRC approved computer codes:

- Monte Carlo code MCNP4a
- CASMO-4

MCNP4a is a continuous energy three-dimensional Monte Carlo code developed at Los Alamos National Laboratory. MCNP4a was the primary code used in the MPC-32 criticality calculations. Benchmark calculations indicate a bias of 0.0009 with an uncertainty of ±0.0011 for MCNP4a, evaluated with a 95% probability at the 95% confidence level. The MCNP code bias effect was also applied directly in each of the final k_{eff} calculations as a bias. The relative statistical error was calculated in each MCNP run, and the two sigma value was included as an uncertainty.

The convergence of a Monte Carlo criticality problem is sensitive to the following parameters: the number of histories per cycle; the number of cycles skipped before averaging; the total number of cycles; and the initial source distribution. The MCNP4a criticality output contains a great deal of useful information that may be used to determine the acceptability of the problem convergence. This information has been used in parametric studies to develop appropriate values for the aforementioned four criticality parameters to be used in criticality calculations. Based on these studies, the final calculations use a minimum of 10,000 histories per cycle, a minimum of 25 cycles were skipped before averaging, a minimum of 100 cycles were accumulated, and the initial source was specified as uniform over the fueled regions (assemblies).

Fuel depletion analyses during core operations were performed with CASMO-4. CASMO-4 is a two-dimensional multi-group transport theory code developed by Studsvik of Sweden. CASMO-4 performs cell criticality calculations and burnup. CASMO-4 has the capability of analytically restarting burned fuel assemblies in an infinite representation of the MPC-32 configuration. This code was used to determine the isotopic composition of the fuel and the reactivity effects of tolerances (e.g., manufacturing tolerances of the MPC-32 basket and fuel enrichment tolerances) and fuel depletion. For spent fuel criticality calculations in the MPC-32, some of the fission product isotope concentrations including Xenon-135 in the fuel were conservatively set to zero.

To perform the criticality evaluation for spent fuel in MCNP, the isotopic composition of the fuel was calculated with the depletion code CASMO and then specified as input data in the MCNP run. The CASMO calculations used to obtain the isotopic compositions for MCNP were performed generically, with one calculation for each enrichment, and burnups in increments of 2.5 gigawatt days per metric ton of Uranium (GWD/MTU) or less. The isotopic composition for any given burnup was then determined by linear interpolation.

Initially, fuel loaded into the reactor will burn with a slightly skewed cosine power distribution. As burnup progresses, the burnup distribution will tend to flatten, becoming more highly burned in the central regions than in the upper and lower ends. At high burnup, the more reactive fuel near the ends of the fuel assembly (less than average burnup) occurs in regions of lower reactivity worth due to neutron leakage. Consequently, it would be expected that over most of the burnup history, distributed burnup fuel assemblies would exhibit a slightly lower reactivity than that calculated for the average burnup. As burnup progresses, the distribution, to some extent, tends to be self-regulating as controlled by the axial power distribution, precluding the existence of large regions of significantly reduced burnup.

Generic analytic results of the axial burnup effect for assemblies without axial blankets were provided based upon calculated and measured axial burnup distributions. These analyses confirmed the minor and generally negative reactivity effect of the axially distributed burnup, becoming positive at burnups greater than about 30 GWD/MTU. The trends observed suggest the possibility of a small positive reactivity effect above 30 GWD/MTU increasing to slightly over 1% Δk at 40 GWD/MTU. To assess the effect of axial burnup distribution on the reactivity, the MCNP criticality calculations were carried out. The calculations indicate that the uniform axial burnup yields higher multiplication factor. To maintain conservative conditions, the uniform axial burnup was deployed in criticality calculations.

Pool water temperature effects on reactivity were calculated with CASMO-4. The results show that the spent fuel pool temperature coefficient of reactivity is negative, i.e. a lower temperature results in a higher reactivity. In MCNP, the Doppler treatment and cross-sections are valid only at 300K (27°C). Therefore, a Δk was determined in CASMO-4 from 300K to 273K, and was included in the final k_{eff} calculation as a bias. Based on this, the moderator temperature was treated as 1.0 g/cc in the analysis.

Uncertainties

The uncertainties were statistically combined via square root of the sum of the squares. The statistical combination of uncertainties plus the biases were added to the MCNP calculated k_{eff} in order to determine the maximum k_{eff}. The maximum k_{eff} was then verified to meet the requirements of 10 CFR 50.68. Since the analysis did not credit soluble boron under normal conditions, it was necessary to demonstrate that k_{eff} was less than 0.95 with the MPC flooded with fresh water. The maximum calculated reactivities were calculated with a 95% probability at a 95% confidence level. Reactivity effects of accident conditions were also evaluated to assure that under all credible conditions, the reactivity will not exceed the regulatory limit of 0.95, considering the presence of an acceptable soluble boron level.

Depletion Calculations

Since critical experiment data with spent fuel is not available for determining the uncertainty in burnup-dependent reactivity calculations, an allowance for uncertainty in reactivity was assigned based upon other considerations. Assuming the uncertainty in depletion calculations is less than 5% of the total reactivity decrement; a burnup dependent uncertainty in reactivity for burnup calculations may be assigned. The depletion uncertainty was determined using two MCNP calculations, one with the highest burnup fuel and one with fresh fuel of the same enrichment. The depletion uncertainty was then equal to 5% of the difference in k_{eff} between the two cases.

Eccentric Fuel Assembly Positioning

The base criticality calculations assumed that the fuel assemblies are centered within their respective basket cells. To account for shifting of assemblies within the cell that result in a more reactive configuration, MCNP calculations were performed to obtain an eccentric positioning uncertainty. One model had all assemblies shifted towards the center of the basket, and the other model had all assemblies shifted towards the periphery of the basket. The more reactive of the two cases was compared with the nominal and the difference was used as the uncertainty.

MPC-32 DESIGN

The MPC-32 basket geometry model is based on the MPC-32 licensing drawings in conjunction with the MPC-32 design drawings and the basic layout drawing is provided in Figure 1. The MPC-32 is placed within a transfer cask and is positioned within the ANO-2 cask loading pit.

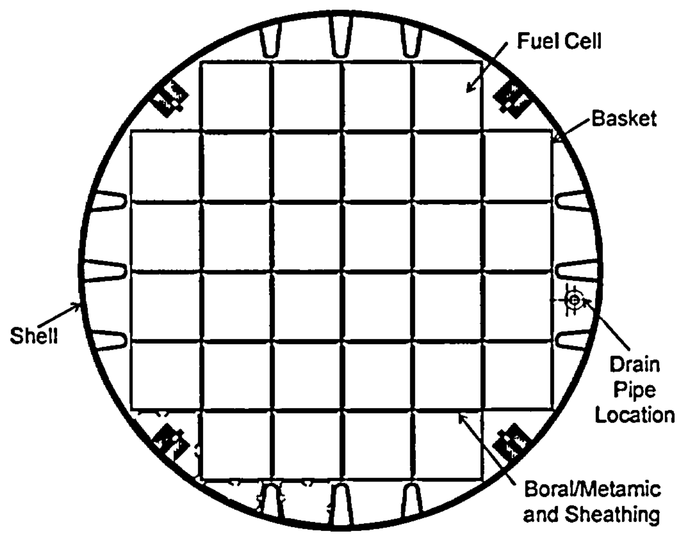


Figure 1, MPC-32 Basket

The criticality calculation adequately represents an MPC-32 loaded into a transfer cask; however, the system was not modeled exactly. The basket and fuel assembly characteristics that are of most important to the criticality evaluation were modeled. Differences between the model and the actual configuration were either conservative or have insignificant effects on reactivity and are listed below:

1. Only the active region of the fuel assembly was explicitly modeled. This included the basket poison material and the sheathing.
2. Six inches of water was modeled above the active fuel, followed by 15.5 inches of steel.
3. Four inches of water was modeled below the active fuel followed by 8.5 inches of steel.
4. Radially, the MPC-32 basket was inscribed in a 67.378 inch diameter cylinder of water, followed by 9 inches of steel.
5. The MPC-32 shell internals were not modeled.
6. The MPC-32 basket plates radially extend through the exterior water to the steel.
7. Material composition of the structural materials was considered to be stainless steel.
8. The poison material was modeled as a homogenous material with an elemental composition representative of Boral panels. The B-10 areal density of the poison material was assumed to be 0.031 g/cm^2, consistent with the proposed B-10 areal density for Metamic poison panels in the MPC-32. This value bounds the minimum required B-10 loading for Boral of 0.0372g/ cm^2. Boral and Metamic have been demonstrated as identical from a criticality perspective. Therefore, this analysis is valid for an MPC-32 cask with either Metamic or Boral as the poison material.
9. A cell wall (basket plate) thickness tolerance of 0.06 inches was used.
10. The MPC-32 was assumed to be located in a HI-STAR overpack which bounds the HI-TRAC.
11. The MPC-32 nominal fuel assembly cell pitch used is 9.158".

ANALYSES CONSIDERATIONS

The following assumptions were employed in the analysis:

1. All depletion calculations were performed with 3 years of cooling time credited, which bounds the minimum cooling time allowed for spent fuel storage in the MPC-32.
2. Neutron absorption in minor structural members was neglected, i.e., spacer grids were replaced with water.
3. No credit was taken for the potential presence of control components in fuel assemblies when the assemblies are in the MPC-32.
4. The clad pellet gap was conservatively assumed to be flooded with water.
5. The MPC-32 and the HI-TRAC are located in the cask pit area, which is assumed to be neutronically isolated from the rest of the SFP because the loaded fuel will be at least 12 inches from fuel stored in the adjacent racks. Therefore interfaces need not be considered.
6. The pellet outside dimension was modeled at 0.3255 inches, which bounds the actual 0.325 inch dimension.

Table 3 shows the relationship between the Part 50 and Part 72 fuel enrichment allowances and analytical assumptions, as well as the center to center distance between fuel assemblies placed in either the SFP racks or in the MPC-32. It is clearly demonstrated that the requirements of ANO-2 TS 3.9.12.a is bounding. The center to center distance between fuel assemblies in the MPC-32 is smaller than the center to center distance between fuel assemblies in the fuel racks.

Table 3
SFP Rack Verse MPC-32 Enrichment and Cell Pitch Requirements

	Fuel Enrichment (wt%)	Center to Center Distance between Fuel Assemblies in Storage Racks
ANO-2 TS 3.9.12.a / TS 5.3.1.d	4.55 ± 0.05 (TS 3.9.12.a)	Nominal 9.8 (TS 5.3.1.d)
MPC-32 Part 50 Analysis Assumption	4.95	9.158
MPC-32 Part 72 Analysis Assumption	5.0 (CoC, Appendix B)	9.158 (CoC, Appendix B)

SUMMARY OF MPC-32 CRITICALITY ANALYSES

The maximum calculated reactivity values included the effects of uncertainties and basis in each reactivity calculation, calculated with a 95% probability at a 95% confidence level. Table 4 summarizes these effects.

Table 4
K_{eff} Adjustment for Uncertainties and Biases

Uncertainties	
Bias Uncertainty (95%/95%)	0.0011
Calculational Statistics (95%/95%, 2.0×σ)	0.0016
Min Cell ID, Reduced Pitch	0.0033
Increased box thickness, Reduced Inside Diameter	0.0040
Fuel Enrichment Tolerance	0.0020
Depletion	0.0097
Eccentric Positioning	0.0050
Statistical Combination of Uncertainties	0.0124
Biases	
Calculational Bias	0.0009
Temperature Δk (from 300K to 273K)	0.0030
Total k_{eff} Adjustment	0.0164 (Note 1)

Note 1: Round-off is included.

In order to assure k_{eff} does not exceed the 10 CFR 50.68 limit of 0.95 with no credit for soluble boron, fuel assembly burnup and fission product decay was credited. The calculations were performed with credit for 3 years of decay in the changes in fission product concentrations. Calculations for various U-235 fuel enrichments were performed to determine acceptable minimum burnups up to a bounding value of 4.95 wt%. The enrichments were varied from 2.5 wt% to 4.95 wt%. The burnup verse enrichment values are tabulated in Table 5, and are plotted in the proposed TS Figure 3.9-1 in Attachment 2. A bounding linear equation was established based on this data yielding the following:

FA BU ≥ 9E – 16 (GWD/MTU)
FA CT ≥ 3 (years)

Where FA BU = Fuel assembly burnup
E = Initial average fuel assembly enrichment
FA CT = Fuel assembly cooling time from last at power operations

For an assembly with 3 years or greater cooling time an assembly will have to obtain a burnup greater than the calculated value using this equation for a given average fuel assembly enrichment.

The Part 50 analysis concluded that k_{eff} would remain below 0.95 when fuel was loaded/unloaded in the MPC-32 when a combination of cooling time, burnup and initial enrichment was considered prior to inserting the assembly in the MPC-32 basket. The associated loading restrictions represent the proposed change to the ANO-2 TS.

Table 5
Enrichment Verses Burnup for an MPC-32 with CE 16 x 16 Fuel and 3 Years Cooling Time

Enrichment 235U wt%	Burnup (GWD/MTU)	k_{eff}
2.2	0	0.9494
2.5	5	0.9367
3.0	10	0.9384
3.5	15	0.9413
4.0	19	0.9475
4.5	24	0.9453
4.95	28	0.9482

Abnormal and Accident Conditions

The Part 50 analysis also evaluated the effects on reactivity for credible abnormal and accident conditions. There are fuel handling scenarios described below that can be postulated to increase reactivity. However, for these accident conditions, the double contingency principle of ANS N16.1-1975 is applied. This states that it is unnecessary to assume two unlikely, independent, concurrent events to ensure protection against a criticality accident. Thus, for accident conditions, the presence of soluble boron in the storage pool water can be assumed as a realistic initial condition since its absence would be a second unlikely event.

For the abnormal operating condition where there is a loss of SFP Cooling, boiling or the creation of voids could occur. These water density and temperature effects on reactivity have been calculated and the results show that the SFP temperature coefficient for the MPC-32 reactivity is negative, and that introducing voids in the water internal to the storage cell (to simulate boiling) further decreases reactivity. The soluble boron in the SFP water assures that the true reactivity is always less than the limiting value for this abnormal condition.

Two types of drop accidents have been considered: a vertical drop accident and a horizontal drop accident. The current TS SFP boron concentration of 2000 ppm ensures that the fuel remains in a subcritical array for both of these drop accidents.

- A vertical drop resulting in an assembly leaning immediately adjacent to the HI-TRAC overpack would have an insignificant effect on reactivity due the thickness of the HI-TRAC overpack itself (at least 12 inches) between loaded assemblies and the dropped assembly.
- A fuel assembly dropped on top of the MPC-32 basket will come to rest horizontally on top of the MPC since the assembly is longer than the diameter of the HI-TRAC overpack. Even if the assembly were to land partially on top of the basket, there would be approximately 12 inches of space between active fuel regions, which is sufficient to preclude interaction between the dropped assembly and the stored fuel.

It is also possible to vertically drop an assembly into a location occupied by another assembly. Such a vertical impact would, at most, cause a small compression of the stored assembly, reducing the water-to-fuel ratio and thereby reducing reactivity. In addition the distance between the active fuel regions of both assemblies will be more than sufficient to ensure no neutron interaction between the two assemblies. The soluble boron in the SFP water assures that the true reactivity is always less than the limiting value for this dropped fuel accident.

Analyses were performed to evaluate misalignment of the active fuel region within a MPC-32 by means of a dropped fuel assembly. A very conservative bounding accident condition was analyzed postulating the loss of all absorber material throughout the entire basket. For this accident analysis, a 950 ppm soluble boron concentration was assumed which is below the Unit 2 minimum SFP TS limit of 2000 ppm. The results of this postulated accident condition shows that the maximum k_{eff}, including bias and tolerance uncertainties, is below 0.95. This is a very conservative evaluation since an actual dropped assembly at most would be expected to only damage absorber panels in and around one cell.

The misplacement of a fresh unburned fuel assembly was performed with fresh fuel assemblies with an U-235 enrichment up to 5.0 wt%. The results of the analyses demonstrate that a misplacement event would require the presence of 400 ppm soluble boron in the pool water to ensure a five percent subcriticality margin.

As discussed in Section 9.1.2 of the ANO-2 SAR, a dilution event is a credible event. The impact on criticality within the MPC-32 was addressed by performing the analysis to show that k_{eff} remains below 0.95 when fully flooded with unborated water. Table 6 shows the relationship between the Part 50 and Part 72 criticality analysis that were performed in relationship to boron concentration. The conclusions clearly reflect that the ANO-2 TS 3.9.12.c minimum boron requirements (i.e., SFP boron concentration > 2000 ppm) ensure k_{eff} remains below 0.95 in all postulated accident conditions.

Table 6
Summary of Part 50 and Part 72 Boron Concentration Requirements

Criticality Analysis	TS Boron Concentration (ppm)	Criticality Assumptions Boron Concentration (ppm) $k_{eff} \leq 0.95$	Misloading Accident Analysis Boron Concentration (ppm) $k_{eff} \leq 0.95$	Dropped Fuel Assembly Boron Concentration (ppm) $k_{eff} \leq 0.95$	Misalignment of Active Fuel Region Boron Concentration (ppm) $k_{eff} \leq 0.95$
SFP Part 50	>2000	240	825	825	2000
MPC-32 Part 50	>2000	0	400	0	950
MPC-32 Part 72	>1900 CoC LCO 3.3.1	1900	not analyzed	not analyzed	not analyzed

<u>HI-STORM 100 MPC-32 Conclusions</u>

By imposing loading/unloading restrictions on fuel that will be loaded in the MPC-32 in accordance with the proposed TS 3.9.12.d, 10 CFR 50.68 criticality requirements are satisfied. Adherence to the loading/unloading restrictions ensures that k_{eff} remains below 0.95 with no credit for soluble boron at a 95% probability with a 95% confidence level.

The accidents that have been postulated to occur in the SFP were analyzed for the MPC-32. The maximum boron concentration requirement was determined to be 950 ppm. The calculations were performed to show k_{eff} remains below 0.95 at a 95% probability with a 95% confidence level. The ANO-2 TS requirement to maintain boron concentration greater than 2000 ppm is bounding and therefore no change is required.

5.0 REGULATORY ANALYSIS

5.1 Applicable Regulatory Requirements/Criteria

The proposed changes have been evaluated to determine whether applicable regulations and requirements continue to be met.

Because no design changes are associated with Spent Fuel Pool (SFP) storage or handling systems to support loading/unloading a Holtec International Multi-Purpose Canister (MPC)-32, the following 10 CFR 50, Appendix A, General Design Criteria (GDC) remain satisfied:

- GDC 61 – Fuel Storage and Handling Radioactivity Control
- GDC 62 – Prevention of Criticality in Fuel Storage and Handling
- GDC 63 – Monitoring Fuel and Waste Storage

Arkansas Nuclear One, Unit 2 (ANO-2) complies with the requirements of 10 CFR 50.68, *Criticality accident requirements.*

Entergy has determined that the proposed changes do not require any exemptions or relief from regulatory requirements, and do not affect conformance with any GDC differently than described in the Safety Analysis Report (SAR). Entergy has determined that a Technical Specification (TS) change is appropriate to support loading/unloading an MPC-32.

5.2 Evaluation of 10 CFR 50.36 Criteria in Consideration for Modification of ANO-2 Technical Specifications

Section 182a of the Atomic Energy Act of 1954, as amended, requires applicants for nuclear power plant operating licenses to include technical specifications as a part of the license. The NRC regulatory requirements related to the content of TSs are set forth in 10 CFR 50.36, which requires that the TSs include items in five specific categories, specifically (1) safety limits, limiting safety system settings and limiting control settings; (2) limiting conditions for operation (LCO); (3) surveillance requirements (SR); (4) design features; and (5) administrative controls.

10 CFR 50.36 sets forth the following four criteria to be used in determining whether an LCO is required to be included in the TSs:

(1) Installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary (RCPB):

(2) A process variable, design feature, or operating restriction that is an initial condition of a design basis accident (DBA) or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier;

(3) A structure, system, or component (SSC) that is part of the primary success path and which functions or actuates to mitigate a DBA or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier, or

(4) An SSC which operating experience or probabilistic risk assessment (PRA) has shown to be significant to public health and safety.

The results indicate that the ANO-2 TS for SFP boron concentration provides adequate margin and assurance that during fuel loading/unloading activities in an MPC-32, a subcritical margin of at least 5% is maintained. The analyses also demonstrated that required subcriticality margins are maintained in the event of a postulated accident or credible abnormal condition.

Entergy believes that the four criteria of 10 CFR 50.36 are met as related to loading/unloading an MPC-32 when loading restrictions related to burnup, fuel enrichment and decay time are considered. Therefore, for consistency with the current philosophy of the ANO-2 TS, a change is proposed to add loading restrictions for the MPC-32 to the ANO-2 TS.

5.3 No Significant Hazards Consideration

Entergy Operations, Inc. has evaluated whether or not a significant hazards consideration is involved with the proposed amendment(s) by focusing on the three standards set forth in 10 CFR 50.92, *Issuance of Amendment*, as discussed below.

The Arkansas Nuclear One, Unit 2 (ANO-2) Technical Specifications (TS) govern the spent fuel pool (SFP) boron concentration, the maximum Uranium-235 (U-235) fuel enrichment that can be stored in the SFP, and the loading restrictions based on cooling time, initial fuel enrichment, and fuel burnup. In addition, the ANO-2 TSs govern the criticality requirements, which include maintaining the effective multiplication factor (k_{eff}) less than or equal to 0.95 associated with fuel stored in the SFP. Spent fuel pool loading is also governed by requirements in the Code of Federal Regulations (CFR), specifically 10 CFR 50.68, *Criticality Accident Requirements*. Criticality evaluations are performed for spent fuel that will be stored in the SFP based on the requirements set forth in 10 CFR 50.68.

When loading an MPC-32, a loading restriction is required to ensure the margins to criticality are maintained for both normal and postulated accident conditions. The ANO-2 TS boron concentration in conjunction with the loading restriction ensures the requirements of 10 CFR 50.68 are met while loading/unloading fuel into a storage cask.

The TS governing activities in the SFP will be modified to include loading restrictions for the MPC-32.

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

   Response: No.

   The fuel handling accidents described below can be postulated to increase reactivity. However, for these accident conditions, the double contingency principle of ANS N16.1-1975 is applied. This states that it is unnecessary to assume two unlikely, independent, concurrent events to ensure protection against a criticality accident. Thus, for accident conditions, the presence of soluble boron in the SFP water can be assumed as a realistic initial condition since its absence would be a second unlikely event.

   Loading/unloading a storage cask in the SFP does not affect the previously evaluated fuel handling accidents (i.e., criticality effects) in the SFP. The ANO-2 TS for SFP boron concentration ensures subcritical conditions in the SFP during fuel movement activities, whether within the SFP racks or to a storage cask during normal and accident conditions.

   The cask configuration for the storage cask (MPC-32) is sufficiently similar to spent fuel racks in the SFP as to not induce new or different spent fuel assembly damage in the unlikely event of the occurrence of a fuel handling accident during storage cask loading/unloading activities. The fuel handling accident includes four drop scenarios (fuel drop horizontally on a cask, fuel drop on a fuel assembly, fuel drop next to a cask, and a fuel drop on the cask basket). The same equipment and procedural controls for controlling fuel within the SFP are utilized when loading/unloading a storage cask. In addition, the postulated fuel handling accidents associated with loading/unloading a storage cask are bounded by current ANO-2 TS SFP requirements for minimum boron concentration.

   Loading/unloading a storage cask will have no impact on the boron dilution event probability. The same controls for prohibiting a dilution event during spent fuel movement activities in the SFP are in use when loading/unloading fuel in a cask located in the cask pit.

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

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

   Response: No.

   The storage casks have the same basic design and control of a SFP rack. The cask cell walls are thicker than the SFP rack walls; the outside wall on the cask is thicker than the SFP racks and the space for mishandling is tighter than around the racks. When the cask loading pit gate is open and the Technical Specifications are applicable, the pit is in direct communications with the spent fuel pool. Boron concentrations and decay heat removal for fuel in the cask loading pit is controlled in the same manner as it is for fuel in the spent fuel pool proper.

An accident analysis for the MPC-32 was performed assuming the same SFP rack accidents that are discussed in the ANO-2 SAR. The ANO-2 TS boron concentration assures that a subcritical margin is maintained during any postulated accident condition (i.e., k_{eff} is less than or equal to 0.95).

Therefore, the proposed change does not create the possibility of a new or different kind of accident from any previously evaluated.

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

Response: No.

The ANO-2 TSs require for criticality concerns in the SFP that k_{eff} remain less than or equal to 0.95. For the MPC-32, the criticality analysis demonstrated that when the ANO-2 TS for SFP boron concentration is met, a loading restriction is required to ensure k_{eff} remains less than or equal to 0.95. The proposed change to the ANO-2 TS will ensure the criticality margin is maintained.

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

Based on the above, Entergy concludes that the proposed amendment(s) present no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

5.4 Environmental Considerations

The proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 REFERENCES

1. Entergy letter to the NRC dated February 24, 2003, "Proposed License Amendment for Increase in Handling Heavy Loads for Arkansas Nuclear One's Spent Fuel Crane" (0CAN020307)
2. NRC letter to Entergy dated July 25, 2003, "Issuance of Amendments RE: Allowing the use of the Spent Fuel Crane to Lift Heavy Loads in Excess of 100 Tons (TAC NOS. MB7799 AND MB7800) (0CNA070304)
3. Entergy letter to the NRC dated July 7, 2005, *Pre-Application Review for License Amendment Request Regarding ANO-2 Cask Loading Pit Criticality Analysis* (2CAN070502)

Attachment 2

2CAN070503

Proposed Technical Specification Changes (mark-up)

FUEL STORAGE

LIMITING CONDITION FOR OPERATION

3.9.12.a Storage in the spent fuel pool shall be restricted to fuel assemblies having initial enrichment less than or equal to 4.55 ± 0.05 w/o U-235. The provisions of Specification 3.0.3 are not applicable.

3.9.12.b Storage in the spent fuel pool shall be further restricted by the limits specified in Figure 3.9.2. The provisions of Specification 3.0.3 are not applicable.

3.9.12.c The boron concentration in the spent fuel pool shall be maintained (at all times) at greater than 2000 parts per million.

3.9.12.d Storage in the MPC-32 shall be further restricted by the limits specified in Figure 3.9-1. The provisions of Specification 3.0.3 are not applicable.

APPLICABILITY: During storage of fuel in the spent fuel pool (Note: The tilt pit and cask loading pit are considered part of the spent fuel pool when their respective gates are open).

ACTION:

Suspend all actions involving the movement of fuel in the spent fuel pool if it is determined a fuel assembly has been placed in an incorrect location until such time as the correct storage location is determined. Move the assembly to its correct location before resumption of any other fuel movement.

Suspend all actions involving the movement of fuel in the spent fuel pool if it is determined the pool boron concentration is less than 2001 ppm, until such time as the boron concentration is increased to 2001 ppm or greater.

SURVEILLANCE REQUIREMENTS

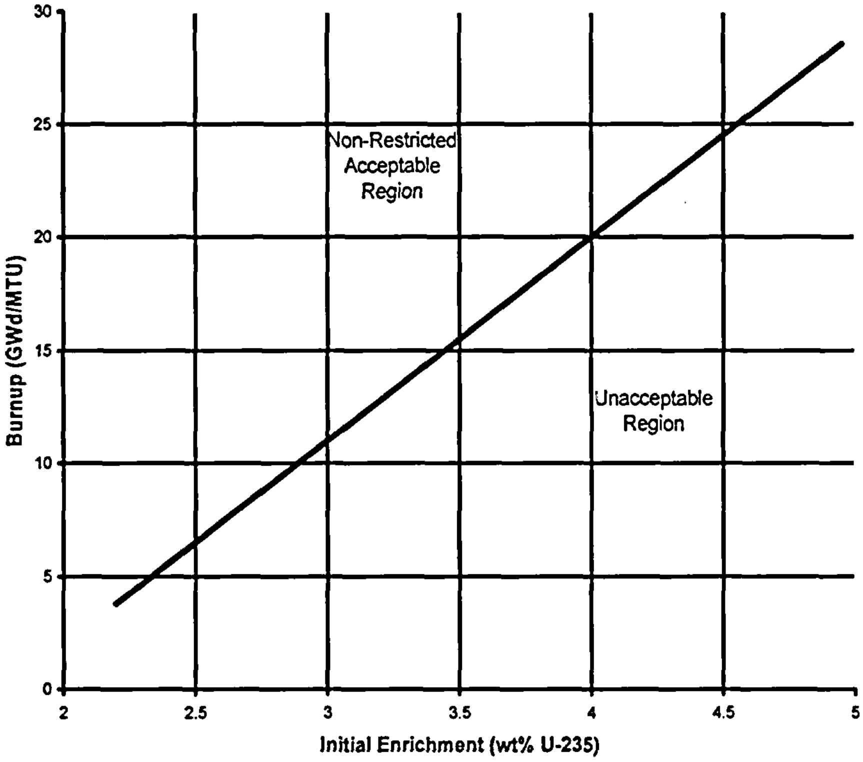
4.9.12.a Verify all fuel assemblies to be placed in the spent fuel pool have an initial enrichment of less than or equal to 4.55 ± 0.05 w/o U-235 by checking the assemblies' design documentation.

4.9.12.b Verify all fuel assemblies to be placed in the spent fuel pool are within the limits of Figure 3.9.2 by checking the assemblies' design and burnup documentation.

4.9.12.c Verify at least once per 31 days the spent fuel pool boron concentration is greater than 2000 ppm.

4.9.12.d Verify all fuel assemblies to be placed in a storage cask are within the limits of Figure 3.9-1 by checking the assemblies' design and burnup documentation.

Figure 3.9-1
Loading Restrictions for MPC-32
(Fuel Cooling Time > 3 years)



Attachment 3

2CAN070503

List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Entergy in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
The ANO-2 SAR will be modified for MPC-32 to reflect the assumptions and conclusions of the criticality analyses performed using the criticality analysis requirements associated 10 CFR 50.68.	x		