

**From:** "MILLAR, DANA" <DMILLAR@entergy.com>  
**To:** "Thomas Alexion" <TWA@nrc.gov>  
**Date:** 7/21/03 4:46PM  
**Subject:** ANO-2 Spent Fuel Pool Loading Pattern RAIs

Tom,

Please see the attached draft response to the Reactor Systems Branch RAIs related to the ANO-2 Spent Fuel Pool Loading Patterns.

Thanks,

Dana

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**Subject:** ANO-2 Spent Fuel Pool Loading Pattern RAIs  
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2CAN0703XX

July 24, 2003

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

**SUBJECT:** Supplement to Amendment Request to  
Revise the Spent Fuel Pool Loading Pattern  
Arkansas Nuclear One, Unit 2  
Docket No. 50-368  
License No. NPF-6

**REFERENCES:** 1. Letter dated June 30, 2003 to the NRC, License Amendment  
Request to Revise the Spent Fuel Pool Loading Pattern  
(2CAN060306)

Dear Sir or Madam:

By letter (Reference 1), Entergy Operations, Inc. (Entergy) proposed a change to the Arkansas Nuclear One, Unit 2 (ANO-2) Technical Specifications (TSs) to revise the spent fuel pool (SFP) loading pattern.

On July 14, 2003, Entergy received a request for additional information from the Reactor Systems Branch. There were 14 questions which were determined to need formal response. Entergy's response is contained in Attachment 1.

Attachment 2 contains a minor change to one marked up page of the TS. A previously approved TS amendment number referenced on the page is being corrected.

There are no technical changes proposed. The original no significant hazards consideration included in Reference 1 is not affected by any information contained in the supplemental letter. There are no new commitments contained in this letter.

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

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

Sincerely,

SRC/dm

**Attachments:**

1. Response to Request For Additional Information
2. Revised Markup of Technical Specification Pages

cc: Mr. Thomas P. Gwynn  
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Attn: Mr. Thomas W. Alexion MS O-7D1  
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Mr. Bernard R. Bevill  
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Arkansas Department of Health  
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**Attachment 1**

**To**

**2CAN0703XX**

**Response to Request for Additional Information**

**Request for Additional Information - Reactor Systems Branch**  
**Amendment Request to Revise Spent Fuel Pool Loading Pattern**  
**Arkansas Nuclear One, Unit 2**

**Question 1:**

The licensee's amendment identifies Combustion Engineering (CE) 16 x 16 spent and fresh fuel assemblies as the fuel types stored in the spent fuel pool and, therefore, used in the criticality analysis. The staff requests the licensee to specify if any other fuel types are currently stored in the ANO-2 spent fuel pool. If additional fuel types are stored in the pool, the staff requests the licensee to demonstrate quantitatively that the CE 16x16 assemblies provide the most conservative criticality analyses.

**Response 1:**

No fuel types other than CE 16x16 fuel assemblies are currently stored in the Arkansas Nuclear One, Unit 2 (ANO-2) spent fuel pool (SFP). Storage of any other fuel assembly type in the ANO-2 fuel handling area is procedurally prohibited. It would also be physically impossible to store B&W 15 x 15 fuel assemblies because these fuel assemblies are wider than the cell openings.

If different fuel types are used in the future, changes to the fuel assembly design, key fuel assembly mechanical features, and the changes in operating strategy will be evaluated under 10 CFR 50.59, "Changes, tests and experiments."

**Question 2:**

Attachment 1 of the June 30, 2003, application references two types of CEAs inserted in fresh and spent fuel assemblies. Are there differences in reactivity worth between the two types of CEAs? If so, was this difference accounted for in the criticality calculation of the pertinent assemblies?

**Response 2:**

There are two types of CEAs associated with the ANO Unit 2 SFP, hereafter referred to as newer and older CEA types. The difference between the two CEA types is only in the central rod. The central rod in the newer CEA type has an Ag-In-Cd annular plug in the lower region. The central rod of the older type of CEAs has a lower region containing a solid Inconel plug.

The older type CEAs are conservatively modeled in the analysis with the same active B<sub>4</sub>C region as the current CEAs and the Inconel plug is neglected. There is a slight difference in the reactivity effect between the two CEA types mainly due to the as-modeled conservatism in the older type assembly. The maximum effect can be seen in differences in results from two  $k_{eff}$  calculations of fresh fuel assemblies, one with a new type CEA and one with an old. The older CEA type is more reactive ( $\Delta k = 0.0045$ ). Thus, spent fuel modeled with the older type CEAs bounds all spent fuel assemblies containing CEAs.

Only new type CEAs will be placed in fresh assemblies to create the Fc type of assembly

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referred to in the report (for pattern 4). For spent fuel assemblies that contain CEAs, only the old types of CEAs are assumed to be present (even though either an old or new type CEA may be inserted in the spent fuel). Administrative controls will ensure that only the newer types of CEAs are inserted into fresh fuel assemblies when using pattern 4.

**Question 3:**

The current configuration of the spent fuel pool at ANO-2 is a two region configuration. It is not clear if this configuration has been retained for this proposed change to the ANO-2 Technical Specifications. Please provide additional clarification.

**Response 3:**

The proposed change eliminates the Region 1 and Region 2. No credit will be taken for the Boraflex that is contained in the current Region 1. The proposed loading patterns and associated interfaces may be implemented at any location in the SFP.

**Question 4:**

The application also proposed that the boron concentration in the spent fuel pool be increased to 2000 ppm. Is this the same value as in the boron storage tank?

**Response 4:**

Boron concentration in the refueling water storage tank is maintained between 2500 and 3000 parts per million (ppm) in accordance with ANO-2 Technical Specification (TS) 3.5.4.

**Question 5:**

The subject of "bounding polynomials" was raised in Attachment 1 and in the Holtec report. However, no basis was provided for the number of terms included or the obtained values of the coefficients. Please provide the technical justification and an example of how one of the polynomials is developed.

**Response 5:**

Third order polynomial fits were developed to conservatively predict the burnup requirements of the spent fuel assemblies. The fits were first generated using Excel, which develops the trend line equation from the calculated burnup requirement data using the least squares method. Then the linear term (constant) in the equations were adjusted to conservatively bound all data points.

**Question 6:**

Figure 3.9.2 on page 3/4 9-17 indicates a dashed vertical line between Pattern 1 and the remaining four patterns. Please explain the presence of the dashed line in this figure.

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**Response 6:**

The dash lined represents a separation between the pattern on the left and the patterns on the right. When configuring the SFP loading patterns, the pattern defined on the left side of the dashed line can be placed next to any of the patterns defined on the right side of the dashed line. The orientation of the patterns with the designed fuel types is limited to those defined in Figure 3.9-2.

**Question 7:**

On page 7 of the Holtec report, bullet no. 6 in the list of assumptions makes reference to assumed "conservative operating conditions." Please provide clarification of these conditions.

**Response 7:**

The conditions used in the CASMO input were conservative compared to nominal operating parameters such that a higher reactivity spent fuel is produced throughout the depletion calculation. The operating parameters used in the analyses are listed below.

Parameter	Nominal Value
Average $T_{\text{fuel}}$	1010 °F
Moderator $T_{\text{average}}$	578.93 °F
Moderator $T_{\text{outlet}}$	604 °F
Soluble Boron Used	900 ppm

**Question 8:**

Also on page 7, bullet no. 7 makes reference to "absorber rods" being treated as fuel rods in the criticality analysis. Are absorber rods the same thing as CEAs? If so, what U-235 enrichment was assigned to these rods?

**Response 8:**

The absorber rods referred to in that assumption are any Integral Burnable Poison Rods (IBPRs) that may exist within the fuel assemblies, not CEA rods.

**Question 9:**

It is not clear to the staff (from reading the application) what role the CEAs played in meeting and maintaining the subcriticality requirements of 10 CFR 50.68 or any other



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regulatory requirement(s).

- a. Please provide references to applicable codes, standards, and regulatory requirements, permitting the use of CEAs as neutron absorbing material in spent fuel pool criticality calculations. (Be specific as to which document, section, etc., is being referenced.)
- b. It is stated in Table 1.1, that CEAs were used in 4 of the 9 rankings. Besides the obvious effect of the presence of the CEAs in the chosen assemblies (i.e., suppressing the reactivity in that assembly), were the criticality requirements of 10 CFR 50.68 met with or without the presence of these CEAs in the assemblies?
- c. If the CEAs were included in the criticality calculations, please provide qualitative and quantitative technical information as to how the CEAs were accounted for in Monte Carlo N-Particle Transport Code MCNP and any other calculational method used to meet the regulatory requirements.

Response 9:

- a. The NRC guidance document, "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants" by Laurence I. Kopp dated June 1998 provides an allowance for the crediting the use of absorbers such as rods. This is found in section 5.B, item 5 as follows:

"Normally, credit may only be taken for neutron absorbers that are an integral (nonremoveable) part of a fuel assembly or the storage racks. Credit for added adsorber (rods, plates, or other configurations) will be considered on a case-by-case basis, provide it can be clearly demonstrated that design features prevent the absorbers from being removed, either inadvertently or intentionally without unusual effort such as the necessity for special equipment maintained under positive administrative control."

The last sentence of the above paragraph is satisfied at ANO-2 as follows:

To facilitate removal and insertion of CEAs from fuel assemblies a CEA handling tool is used. Typically, the spent fuel handling tool is attached to the hoist of the spent fuel handling machine. The CEA handling tool is stored in the fuel tilt pit and only attached to the hoist of spent fuel handling machine when CEA movement is desired. Movement of any control component is controlled by procedure. By procedure, positive administrative controls currently exist that require the power supply breaker to the spent fuel handling machine to be maintained locked open when the spent fuel handling machine is not in use. The key to the lock is controlled by the Control Room Supervisor.

Additionally the CEA would not be removed by the fuel handling tool. During withdrawal a fuel assembly by the spent fuel handling machine, the load on the hoist cable is monitored by an electronic load weighing system to ensure movement is not being restricted and to also ensure that the weight is as would be expected for the fuel assembly that is being moved. A CEA only weighs about 52 pounds while a fuel assembly weighs between 1200 and 1300 pounds.

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- b. The 10CFR50.68 requirements could only be met with the presence of CEAs.
- c. The CEAs were modeled explicitly in MCNP with some conservative assumptions as described in the response to question 2, and approximately 5% reduction in density in poison containing materials to account for the <3% predicted burnout rate.

**Question 10:**

The licensee provided tables showing the minimum burnup required for storage of spent fuel assemblies in each of the racks as a function of cooling time and average fuel enrichment. The staff requests the licensee specify if the table values and the figures generated from them assumed the uncertainty in the fuel enrichment. That is, for an enrichment of 4.95 weight percent, was the uncertainty ( $\pm 0.05$  weight percent) considered in the burnup and cooling-times calculations?

**Response 10:**

Yes, fuel enrichment tolerance of 0.05 weight percent is considered as a statistically combined uncertainty and is applied to the upper  $k_{eff}$  limit in each of the cases for the minimum burnup determinations. Note that the upper  $k_{eff}$  limit for each criticality calculation case is equal to the regulatory limit (1.0 for unborated spent fuel pool water or 0.95 with credit for soluble boron in the spent fuel pool water) minus biases minus statistically combined uncertainties.

**Question 11:**

On page 10 of the Holtec report, section 4.2, 3<sup>rd</sup> paragraph, a discussion is presented regarding the determination of the uncertainties associated with the depletion process. This paragraph needs expanding. Please provide clarification as to what is meant by "Conservatively bounding moderator and fuel temperature" and "upon other considerations." Also, it is not clear to the staff what is being conveyed by the second to the last sentence in the same paragraph. Please provide additional clarification of each step presented in this paragraph.

**Response 11:**

**"Conservatively bounding moderator and fuel temperature"**

Please see the answer to question 7 regarding conservatively bounding moderator and fuel temperatures.

**"Upon other Considerations"**

To account for the uncertainty in the depletion calculations, 5% of the delta K between the reactivity of the fresh fuel and the spent fuel and the burnup of interest is included as an uncertainty in the analysis. This approach is based on guidance in the Laurence I. Kopp

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document. The depletion uncertainty was calculated for each of the patterns (except pattern 2 which only contains fresh fuel) using the  $\Delta k$  between two MCNP calculations. The first calculation determines  $k$  for the pattern with the assemblies at the appropriate minimum burnup requirement and 4.55% initial enrichment. The second model is the same except spent assemblies in the first model is replaced with fresh fuel at the 4.55% enrichment. If a CEA is in an assembly in the first model, it remains in the second model.

**Question 12:**

Page 12 of the Holtec report, Section 5.1, nominal design case, describes the determination of  $K_{eff}$  unborated. Did these calculations include assemblies with CEAs inserted in them? Please clarify. (This question ties in with question 10.)

**Response 12:**

Yes, CEAs were credited in assemblies that indicate that a CEA is present.

**Question 13:**

The licensee's criticality analysis has identified the mis-loading of a fresh fuel assembly into a Region 2 cell intended to remain empty, as an event which requires 825 ppm of soluble boron to assure the maximum  $k_{eff}$  does not exceed 0.95.

- a. It is not clear to the staff why reference is made to Region 2 when reference to either Region 1 or 2 is deleted in the TS-requested changes in Attachment 2.
- b. Here again no reference is made as to what role the CEAs played in the analysis. That is, did the misloaded assembly have a CEA inserted in it? Please clarify.
- c. Was the accidental removal of a CEA from an assembly requiring it to be inserted in it, analyzed as a possible accident? If not, please provide technical justification as to why this scenario should not be considered as another accident.

**Response 13:**

- a. The reference to Region 2 was not necessary. If a fresh fuel assembly were inadvertently loaded into any storage cell in the SFP intended to remain empty or to store a spent fuel assembly, credit for a soluble boron concentration of 825 ppm is required to ensure  $k_{eff}$  does not exceed 0.95.
- b. The accident cases all assume that the most reactive assembly in a pattern or interface (whichever is the case being analyzed) is replaced with a fresh assembly that does not contain a CEA.
- c. The analyzed accident condition described above (in 13b) bounds the accidental removal of a CEA from an assembly.

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**Question 14:**

In reviewing Table 2.1, page 20 of the Holtec report, the staff identified differences in values such as 0.0097 and 0.0129 for the manufacturing tolerance uncertainty, 0.0092 and 0.0101 for temperature effects, depletion effects, etc., between the analyses for each of the 5 patterns. Please provide clarification and justification for the differences.

**Response 14:**

The reactivity effects of the manufacturing tolerances and depletion uncertainty, as well as the temperature bias were determined for each pattern separately. The values of the reactivity effects are dependent on the burnup requirements of the fuel assemblies in the storage patterns. To determine the reactivity effects of the manufacturing tolerances and temperature bias, the  $\Delta k_{eff}$  calculations were performed using CASMO at the appropriate depletion steps (or burnup levels). Since the assemblies in patterns 3, 4, and 5 have the same burnup requirements, they also have the same manufacturing tolerance uncertainty and temperature bias. The assemblies in pattern 1 have a slightly different burnup requirement than patterns 3, 4, and 5, thus a different tolerance and uncertainty. This is also true for pattern 2, which contains only fresh fuel so the  $\Delta k_{eff}$  is evaluated at zero burnup. The depletion uncertainty is also evaluated for each specific pattern using MCNP calculations as described in the response to question 11.

**Attachment 2**

**To**

**Letter #**

**Revised Markup of Technical Specification Pages**

## DESIGN FEATURES

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### 5.3 Fuel Storage

#### 5.3.1 Spent Fuel Storage Rack Criticality

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

- a. Fuel assemblies stored in the spent fuel pool in accordance with Specification 3.9.12;
- b.  $k_{eff} \leq 0.95$  if fully flooded with 240 ppm borated water, which includes an allowance for uncertainties as described in Section 9.1 of the SAR; and
- c.  $k_{eff} < 1.0$  if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1 of the SAR; and
- d. A nominal 9.8 inch center to center distance between fuel assemblies placed in the storage racks.

#### 5.3.2 New Fuel Storage Rack Criticality

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

- a. Fuel assemblies having a maximum U-235 enrichment of 4.6 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 of the SAR;
- c.  $k_{eff} \leq 0.98$  if moderated by aqueous foam, which includes an allowance for uncertainties as described in Section 9.1 of the SAR; and
- d. A nominal 26 inch center to center distance between fuel assemblies placed in the storage racks.

#### 5.3.3 Drainage

The spent fuel storage pool is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 399' 10½".

#### 5.3.4 Capacity

The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 988 fuel assemblies.