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2CAN080301

August 1, 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, which contained 14 questions that were determined to need formal response. Entergy's responses are contained in Attachment 1 of this letter.

Attachment 2 contains changes to the marked up TS pages that are associated with the proposed change. A markup to TS page 3/4 9-15 is included, which was not included in the original submittal (Reference 1). The figure on this page will be deleted. On page 5-2, which was included in the original submittal (Reference 1), a previously approved TS amendment number referenced in the footer of 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.

A001

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 1, 2003.

Sincerely,

CGA/dm

Attachments:
1. Response to Request for Additional Information - Reactor Systems Branch
2. Revised Markup of Technical Specification Pages

cc: Mr. Thomas P. Gwynn
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**Attachment 1**

**To**

**2CAN080301**

**Response to Request for Additional Information**

**Reactor Systems Branch**

**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 control element assemblies (CEAs) associated with the ANO-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 old type CEAs are conservatively modeled in the analysis with the same active $B_4C$ region as the current CEAs and the Inconel plug neglected. The new type CEA is a better absorber than the older type CEA and has a higher worth mainly due to the as-modeled conservatism in the older type assembly. Therefore, for conservatism, whenever configurations are modeled where old or new CEAs may be used, the weaker old CEA is used. Spent fuel modeled with the old type CEAs bounds all spent fuel assemblies containing CEAs.

The maximum effect can be seen in the differences of two $k_{inf}$ calculations for fresh fuel assemblies, one with a new type CEA and one with an old. The fuel assembly with the older CEA type inserted is more reactive ($\Delta k = 0.0045$). This change in reactivity was calculated as follows:

$\Delta k$ = ($k_{inf}$ for a fresh fuel assembly with an old CEA inserted) – ($k_{inf}$ for a fresh fuel assembly with a new CEA inserted)

Only new type CEAs will be placed in fresh assemblies to create the Fc type of assembly referred to in the report (for pattern 4). Administrative controls will ensure that only the newer types of CEAs are inserted into fresh fuel assemblies when using 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).

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 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. The deletion of Figure 3.9.1 is included in Attachment 2 to this letter.

Throughout the submittal Region 1 and 2 type racks are referenced due to the fact that the racks are of different design. The Region 1 type racks contain Boraflex, which is degraded, and the Region 2 type racks use the "spacer pockets" design and are more reactive than the Region 1 type racks. The Region 2 type racks are the bounding design and the criticality analysis used the Region 2 type racks.

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:

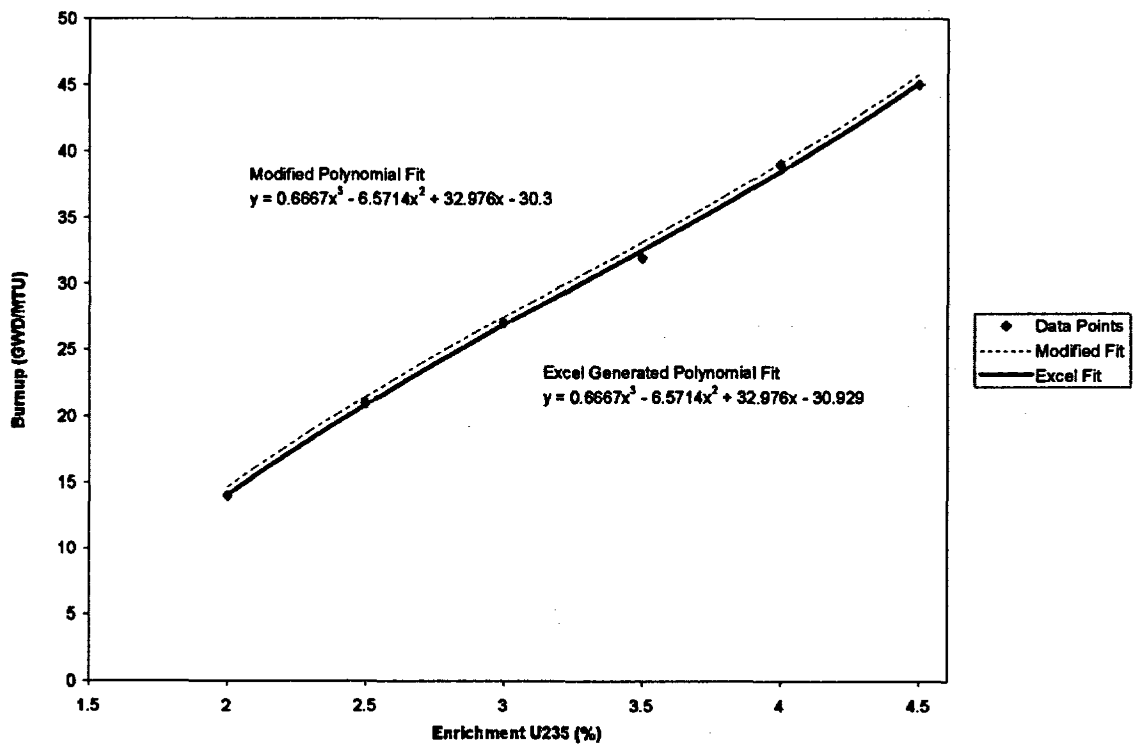
Third order polynomial fits were developed to conservatively predict the burnup requirements of the spent fuel assemblies. The calculated minimum burnup data points are plotted in Excel. A least squares 3rd order polynomial fit equation is then developed in Excel using the trend line function. The following equation is used for calculating the least squares fit:

$$y = C_3 x^3 + C_2 x^2 + C_1 x + b$$

where "b" and "C" are constants.

Plotting the Excel trend line it can be seen that some of the data points are on or above the fit. The equation is revised by adjusting the constant "b" such that all data points are bounded by the revised equation. Each data point is checked to insure the revised equation conservatively predicts the required burnup. The following is an example:

10 Year cooling time, Burnup as a function of Enrichment




In the 10 year cooling trend line graph depicted in the preceding graph, 30.929 in the Excel generated equation was conservatively adjusted to 30.3 in the modified polynomial fit equation so that all data points are bounded by the revised equation.

**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.

**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 designated 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 bounding nominal operating parameters used in the analyses are listed in the following table.

| PARAMETER | BOUNDING NOMINAL VALUES |
|---|---|
| Average $T_{fuel}$ | 1010 °F |
| Moderator $T_{average}$ | 578.93 °F |
| Moderator $T_{outlet}$ | 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 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 preceding paragraph is satisfied at ANO-2 as follows:

   A CEA handling tool is required when removing and/or inserting a CEA. 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 the 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, a CEA would not be removed by the fuel handling tool. During withdrawal of a fuel assembly with 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. The wet weight of a CEA is about 52 pounds while the wet weight of a fuel assembly is between 1200 and 1300 pounds.

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 (± 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, 3rd 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 response to question 7 regarding conservatively bounding moderator and fuel temperatures.

"Upon other Considerations"

To account for the uncertainty in the depletion calculations, an uncertainty equal to 5% of the delta K between the reactivity of the fresh and spent fuel and the burnup of interest is included in the analysis. This approach is based on guidance contained in "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants" by Laurence I. Kopp of the NRC. 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 (p3 in the following example). The second model (p3fresh in the following example) is the same except spent assemblies in the first model are 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.

The following is an example of how the depletion uncertainty was calculated, where depletion uncertainty equals 5% of the reactivity decrement over burnup range.

For pattern 3:

$5\%\Delta k = .05 \times (k_{inf}\,[p3fresh] - k_{inf}\,[p3])$

Where p3fresh is

| | |
|---|---|
| F | FC |
| FC | FC |

And p3 is

| | |
|---|---|
| F | CC |
| CC | CC |

And $k_{inf}$ calculations are performed in MCNP.

Depletion uncertainty for pattern 3:

$5\%\Delta k = .05 \times (1.1161 - 0.9758) = 0.0070$

**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 which 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 in response to question 13b bounds the accidental removal of a CEA from an assembly.

**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 $\Delta k_{inf}$ 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 $\Delta k_{inf}$ 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**

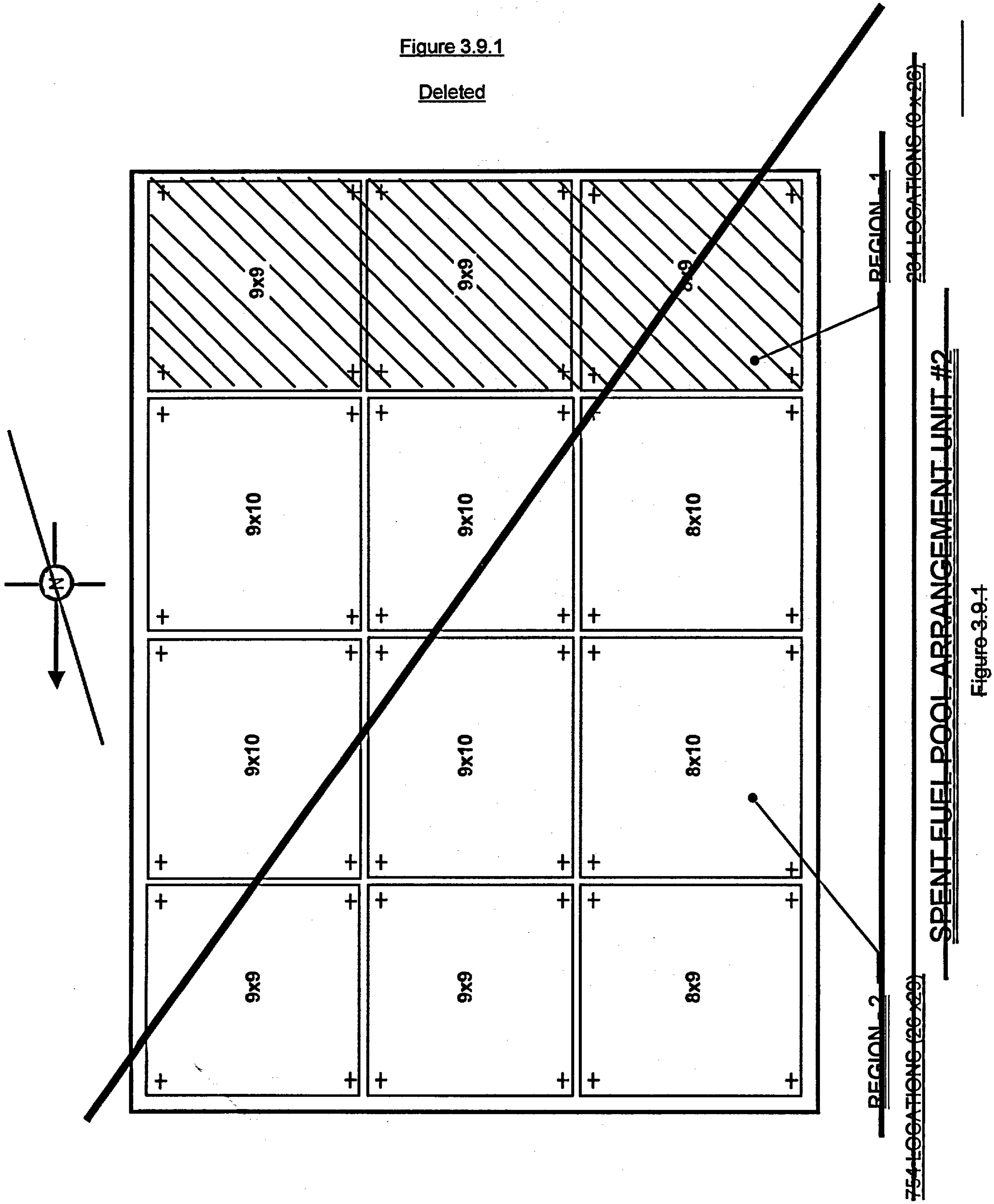
**To**

**2CAN080301**

**Revised Markup of Technical Specification Pages**

<u>Figure 3.9.1</u>

<u>Deleted</u>



## 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 ~~un~~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 ~~5.0~~4.55±0.05 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.