BALTIMORE
GAS AND
ELECTRIC

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ROBERT E. DENTON
VICE PRESIDENT
NUCLEAR ENERGY
(410) 260-4455

November 11, 1992

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Response to NRC Request for Additional Information Regarding the Spent Fuel Pool Enrichment Limit License Amendment
(TAC Nos. M84443; M84444)

REFERENCE:

(a) Letter from Mr. G. C. Creel (BG&E) to NRC Document Control Desk, dated September 1, 1992, License Amendment Request; Spent Fuel Pool Enrichment Limit

(b) Evaluation of AMPX-KENO Benchmark Calculations for High Density Spent Fuel Storage Racks, S. E. Turner and M. K. Gurley, Nuclear Science and Engineering, Vol. 80, pages 230-237, 1982.

(c) Letter from Mr. A. E. Lundvall, Jr. (BG&E) to Mr. R. W. Reid (NRC), dated January 15, 1980, Spent Fuel Pool Modification; Supplementary Information

Gentlemen:

This letter provides Baltimore Gas and Electric (BG&E) Company's response to your request for additional information regarding our License Amendment to change the Spent Fuel Pool enrichment limit (Reference a). Your specific information request and our response are attached.

Our responses do not change or supersede any information contained in the amendment request. Therefore, the responses to these questions do not change or modify the Determination of Significant Hazards presented in the amendment request.

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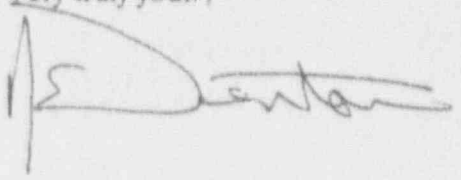
Should you have any further questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,



STATE OF MARYLAND :
: TO WIT :
COUNTY OF CALVERT :

I hereby certify that on the 14th day of November, 1992, before me, the subscriber, a Notary Public of the State of Maryland in and for Calvert County, personally appeared Robert E. Denton, being duly sworn, and states that he is Vice President of the Baltimore Gas and Electric Company, a corporation of the State of Maryland; that he provides the foregoing response for the purposes therein set forth; that the statements made are true and correct to the best of his knowledge, information, and belief; and that he was authorized to provide the response on behalf of said Corporation.

WITNESS my Hand and Notarial Seal:

Donna L. McCready
Notary Public

My Commission Expires:

January 1, 1994
Date

RED/LMD/lmd/dlm

Attachment

cc: D. A. Brune, Esquire
J. E. Silberg, Esquire
R. A. Capra, NRC
D. G. McDonald, Jr., NRC
T. T. Martin, NRC
P. R. Wilson, NRC
R. I. McLean, DNR
J. H. Walter, PSC

ATTACHMENT (1)

Response to NRC Request for Additional Information Regarding the Spent Fuel Pool Enrichment Limit License Amendment

NRC REQUEST

ABB/CE (letter from S. A. Toelle to T. J. Knopp, LD-92-046, March 27, 1992) and others (S. E. Turner, Nuclear Science and Engineering, Vol. 80, pgs. 230-237, 1982) have expressed concern about using the PNL series of critical experiments (S. R. Bierman, et. al., PNL-2438, Oct. 1977) for methodology confirmation. The basic problem is that the worth of the boron in these experiments is relatively low, about 2% compared to about 20% in an actual storage rack. Therefore, modest percent errors in boron worth are manifest as relatively small errors in reactivity (e.g., for a 10% error in poison worth, the error in reactivity would be 0.2%). For a realistic high density storage rack, however, the same 10% error in calculating the reactivity worth of boron absorber plates could result in an error of as much as 5% in reactivity. Based on this, justify the use of the PNL critical experiments for your qualification of the analytical methods and the evaluation of the calculational uncertainty and bias.

BACKGROUND

Asea Brown Boveri-Combustion Engineering (ABB-CE) uses the CEPAK-DOT-XSDRNPM code series to analyze our spent fuel pool poisoned rack configuration to ensure subcriticality is maintained under appropriate storage conditions. CEPAK and XSDRNPM are used to generate the neutron cross sections which are used in the DOT-XY transport code. CEPAK generates the fuel-water cross sections and XSDRNPM generates the Boron-10 (B-10) poison cross sections. In order to verify that the computer codes accurately reflect physical systems, they are benchmarked against experimental critical configurations. CEPAK has been benchmarked against a wide series of critical experiments including those performed at Pacific Northwest Laboratory (PNL). Asea Brown Boveri-Combustion Engineering acknowledges that the PNL criticals are not entirely appropriate for benchmarking the code for use in a highly borated environment. To ensure that the code series performs adequately for calculations of spent fuel pool k_{eff}, ABB-CE has done a code comparison between its CEPAK-DOT-XSDRNPM calculations and Oak Ridge National Laboratory (ORNL) calculations done using AMPX-KENO-XSDRNPM. The AMPX-KENO code series has been benchmarked against both the PNL and the B&W critical experiments, among others. Presented below is a comparison of the two code series for cases ranging from the relatively low B-10 loadings of the PNL criticals to the higher B-10 loadings associated with fuel rack calculations performed using AMPX-KENO.

Comparison of Codes - PNL Criticals

It should be noted that ABB-CE uses the same code as ORNL, XSDRNPM, to calculate B-10 cross sections. Therefore, differences between the ABB-CE and ORNL results are attributable to the difference in the CEPAK-DOT and AMPX-KENO codes.

Reference (b) describes a series of calculations performed to benchmark the AMPX-KENO codes to the PNL critical experiments. Table (1) of the reference provides a comparison of calculations performed by Turner and ORNL for the same criticals. Table (2) of Reference (b) provides an expanded set of critical calculations performed by ORNL. Asea Brown Boveri-Combustion Engineering has calculated k_{eff} for some of these same critical experiments. Table (1) (attached) provides a comparison between the ABB-CE calculations and the available ORNL results. As can be seen from the Table, the mean k_{eff} value calculated by ABB-CE is consistent with the value calculated by ORNL. Therefore, this comparison demonstrates the equivalence between the CEPAK DOT and AMPX-KENO methodologies for systems containing relatively low B-10 loadings.

Comparison Of Codes - Fuel Rack Calculations

Another comparison can be made to AMPX-KENO calculations which were done to support the first re-racking of our spent fuel pool in 1980 (Reference c). The AMPX-KENO methodologies have been adequately benchmarked at higher B-10 loadings and can be used to perform calculations for poisoned fuel racks. Direct comparison with the AMPX-KENO codes provides validation for the use of the CEPAK-DOT code series for the poisoned fuel rack calculations performed in our most recent submittal (Reference a).

AMPX-KENO Bias

When evaluating the use of AMPX-KENO to accurately calculate k_{eff} for the B&W critical series, Turner noted that AMPX-KENO routinely overpredicts k_{eff} (Reference b). He noted an increasing trend of overprediction with increasing boron worth. The highest overprediction occurred with the experiment highest in boron worth (experiment XIII). The bias for that experiment was calculated to be 0.009. Turner extrapolated these results to the boron worths associated with poisoned fuel racks and estimated biases of 0.02 to 0.05 for calculations involving fuel racks. These biases are sometimes used with AMPX-KENO fuel rack calculations. Asea Brown Boveri-Combustion Engineering feels that the trend in biases should be limited to the experimental results (0.009). Therefore, in the following discussion ABB-CE has used the more conservative experimental bias when evaluating the AMPX-KENO results.

In Reference (c), Nuclear Energy Services (NES) used the AMPX-KENO methodology to calculate k_{eff} for our proposed spent fuel pool racks assuming fresh 4.1 w/o U-235 fuel assemblies were being stored. The nominal k_{eff} (without bias) was calculated to be 0.9201. NES used a bias of -0.02, consistent with that estimated by Turner, and reported a k_{eff} of 0.9201-0.02 = 0.9001 in Reference (c). As part of this calculation, NES also determined the scaling factor associated with an increase in fuel enrichment, 0.20 w/o U-235 per percent delta k_{eff}. This allows us to determine the k_{eff} result as a function of increasing enrichment.

As part of the reanalysis for the current spent fuel racks, ABB-CE modelled the same fuel rack as Reference (a) using CEPAK-DOT methodology with fresh 4.3 w/o U-235 fuel instead of 4.1 w/o U-235 fuel. Asea Brown Boveri-Combustion Engineering obtained a nominal k_{eff} value of 0.92308, without bias. If we adjust the NES value to account for the increase in fuel enrichment to 4.3 w/o U-235, the NES k_{eff} value would become 0.9001+0.01 = 0.9101. The 1% increase in k_{eff} is due to the 0.2 w/o U-235 increase in the fuel enrichment (scaling factor from previous paragraph). Comparing the CEPAK-DOT k_{eff} value of 0.92308 to the AMPX-KENO k_{eff} value of 0.9101 for the same configuration with the same fuel allows us to conclude that the CEPAK-DOT methodology is conservative with respect to the AMPX-KENO methodology.

If biases are included in the answers, they compare even more favorably. Taking the NES 4.1 w/o U-235 k_{eff} and applying the more conservative bias of 0.009, k_{eff} would be 0.9111 (0.9201-0.009). After accounting for the difference in fuel enrichment, k_{eff} becomes 0.9211 (0.9111+0.01). Recall that the CEPAK-DOT answer for 4.3 w/o U-235 fuel is 0.92308 without bias. Asea Brown Boveri-Combustion Engineering has calculated a bias for CEPAK-DOT case of 0.00197. Including this bias in the answer, the CEPAK-DOT k_{eff} becomes 0.92111 (0.92308-0.00197). These answers (0.9211 and 0.92111) compare exceptionally well.

To provide further verification of the CEPAK-DOT methodology, ABB-CE used AMPX-KENO methodology to directly calculate k_{eff} for 4.3 w/o U-235 fuel in the fuel racks. The result is 0.93276 ± 0.00346. When the experimentally determined bias of 0.009 is subtracted, the result is 0.92376 (0.93276-0.009). This compares well with the CEPAK-DOT result obtained above, 0.92111.

CONCLUSION

Asea Brown Boveri-Combustion Engineering has benchmarked CEPAK-DOT methodology against PNL critical experiments. The difficulty with this benchmarking method is that it is only applicable for low B-10 loading configurations. This means that additional work is required to ensure that CEPAK-DOT is acceptable as a methodology for modelling spent fuel pool racks which have a high B-10 loading. Therefore, ABB-CE compared their code against identical cases run using the AMPX-KENO methodology. The results of the comparison are given above and in Table (2). It is clear from the comparison that the CEPAK-DOT provides consistent answers with the AMPX-KENO methodology. This comparison, along with the comparison of CEPAK-DOT and AMPX-KENO calculations given in Table (1), allows us to conclude that the CEPAK-DOT methodology produces consistent results with the AMPX-KENO methodology over a wide range of B-10 loadings. Therefore, the acceptability of the CEPAK-DOT methodology for use in fuel rack calculations has been demonstrated.

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TABLE (1)

Comparison of ABB-CE and ORNL Results for the PNL Poisoned Criticals

EXPERIMENT	ABB-CE	ORNL
16	1.002 ± 0.003	1.007 ± 0.005
17	0.997 ± 0.003	NA
20	1.004 ± 0.003	1.010 ± 0.004
32	1.004 ± 0.003	1.004 ± 0.004
33	1.005 ± 0.003	0.999 ± 0.004
38	1.009 ± 0.003	1.000 ± 0.004
39	1.011 ± 0.003	1.002 ± 0.004
Mean k_{eff}	1.004 ± 0.003	1.004 ± 0.004

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TABLE (2)

Comparison of CEPAK-DOT with AMPX-KENO

		bias	k_{eff}
NES Calculation	4.1 w/o	.02	0.9001
NES Calculation (adjusted)	4.3 w/o	.02	0.9101
CEPAK-DOT Calculation	4.3 w/o	-	0.92308
NES Calculation (adjusted)	4.3 w/o	.009	0.9211
CEPAK-DOT	4.3 w/o	.00197	0.92111
ABB-CE AMPX-KENO	4.3 w/o	.009	0.92376
CEPAK-DOT	4.3 w/o	.00197	0.9211