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L-03-011

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Subject: Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
Supplemental Information in Support of LAR No. 165
New Fuel Storage Racks Enrichment Limit

This letter provides the FirstEnergy Nuclear Operating Company (FENOC) response to a NRC request for additional information dated December 30, 2002, pertaining to FENOC letter L-02-070 dated May 31, 2002.

FENOC letter L-02-070 submitted License Amendment Request (LAR) No. 165 that proposed changes to the Beaver Valley Power Station (BVPS), Unit No. 2, which would allow new fuel (fresh fuel) with an enrichment limit of 5.00 weight percent U-235 to be placed and stored in the BVPS Unit 2 new fuel storage racks. Supplemental information is provided in Attachment A of this letter.

This information does not change the evaluations or conclusions presented in FENOC letter L-02-070. If there are any questions concerning this matter, please contact Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement at 724-682-5284.

There are no regulatory commitments contained in this letter. I declare under penalty of perjury that the foregoing is true and correct. Executed on January 30, 2003.

Sincerely,

Mark B. Bezilla

Attachments

A001

c: Mr. D. S. Collins, NRR Project Manager
Mr. D. M. Kern, NRC Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator
Mr. D. A. Allard, Director BRP/DEP
Mr. L. E. Ryan (BRP/DEP)

Letter L-03-011 - ATTACHMENT A

Supplemental Information in Support of
New Fuel Storage Rack Enrichment Limit Increase
for Beaver Valley Power Station, Unit No. 2
(License Amendment Request No. 165)

NRC Request for Additional Information

NUREG/CR-6698 is a guide for validation of nuclear criticality safety calculational methodologies. Table 2.3 of this NUREG contains physical parameters for areas of applicability, including enrichment. A range of appropriate evaluated benchmark experiments is listed given the enrichment to be modeled. There is no question that the benchmark experiments used for the validation are appropriate if they fall within the range listed in the table. However, if the experiments to be credited do not fall within the specified ranges, justification must be provided as to why the experiments used are appropriate.

Page 3, Section 4, of the enclosure to the May 31, 2002, application stated that the methods used in the criticality analysis conform with ANSI/ANS 8.1. From our review, we cannot confirm how you satisfy the requirements of this ANSI standard. Please describe how your methods demonstrate compliance with ANSI/ANS 8.1, paragraph 4.3.1, "Establishment of Bias," and 4.3.2, "Bias Trends," as they relate to areas of applicability, specifically isotopic composition requirements for critical benchmark experiments. This is of particular importance because it is used to establish the validity of your calculated keff.

Explain why the low-enriched experiments detailed in WCAP-14416 (i.e., 2.35 w/o and 2.46 w/o) which supplement the 4.31% enriched experiments are applicable for your validation even though they fall beyond the experimental range suggested by NUREG/CR-6698, Table 2.3.

FENOC Response

The WCAP-14416 method bias and uncertainty, as applied in the Beaver Valley Unit 2 Fresh Fuel Rack Analysis, is more conservative than the applicable guidance currently found in NUREG/CR-6698. This will be shown by comparing the WCAP-14416 bias and uncertainty values to the new bias and uncertainty values developed using the area of applicability guidance in NUREG/CR-6698.

In examining the requirements of Table 2.3 in NUREG/CR-6698, it is apparent that an additional validation of the KENO-Va Code in WCAP-14416 for use at or slightly above 5% enrichment, should use benchmark experiments in the range of 3.5% to 6.5%. Only five benchmark data points from WCAP-14416 fall within this range of applicability (the

4.31% enriched cases). In order to achieve better statistics, an additional set of 5% enriched benchmark cases was executed. A search of the "International Handbook of Evaluated Criticality Safety Benchmark Experiments" identified several sets of Russian experiments involving water moderated U(5%)O_2 rods. These experiments are designated LEU-COMP-THERM-019, 020, 021, 026, and 031, and include a total of 26 available critical experiments which have been deemed acceptable for use as benchmarks. None of these experiments are an ideal match to the Beaver Valley Unit 2 calculations, because the fuel rods were arranged on a hexagonal pitch instead of a square pitch. However, as noted in NUREG/CR-6698 Table 2.3, the geometry of the benchmark case is not considered as important as material specifications.

The seven experiments in LEU-COMP-THERM-020 (LCT-020) provide the closest match to the Beaver Valley Unit 2 Fresh Fuel Rack calculations. The following table compares some key parameters between the LEU-COMP-THERM-020 experiments and the Beaver Valley Unit 2 Fresh Fuel Rack Analysis:

Table 1 – Comparison of LCT-020 Critical Experiments and Beaver Valley Fresh Fuel Rack Analysis

	LCT-020	B.V. U2 Rack Model
Fuel	UO_2	UO_2
Enrichment	5.06%	5.05%
Clad	Zirc Alloy -110	Zirc Alloy –4
Rod Pitch	1.3 cm (hex)	1.26 cm (square)
Interstitial Moderator	Water/Air	Water/Air
Reflector	Water	Water/Concrete
Misc Structural Material	Steel-3, D1 Aluminum Alloy	Stainless Steel, Concrete

The seven experiments from LEU-COMP-THERM-020 were modeled in KENO-Va using the same methods and code versions used by Westinghouse to model the Beaver Valley Unit 2 fresh fuel rack. These additional KENO-Va calculations have been documented and verified. The results of these additional benchmarks are reported in Table 2, along with the five 4.31% enriched cases from WCAP-14416.

The method bias considering only the 12 data points from Table 2 becomes 0.0011 ΔK. The standard deviation of the bias (based only on the Table 2 data) becomes 0.0026 ΔK. Applying a 95/95 one-sided tolerance factor of 2.736 (for n=12) to the standard deviation gives a 95/95 bias uncertainty value of 0.0071 ΔK. Note that the bias uncertainty is higher than the 0.0030 ΔK value reported in WCAP-14416 due to using fewer benchmark cases (n=12 vs. n=32) in this example. Bias uncertainty could be reduced if necessary by

analyzing additional benchmark cases from the original 26 identified LCT cases. The seven additional 5% enriched benchmark cases from LEU-COMP-THERM-020 were run with the same number of neutron histories as the original benchmark cases in WCAP-14416 (i.e., 90000 histories).

Now, the original Beaver Valley Unit 2 Fresh Fuel Rack limiting Keff value calculation (from the optimum moderation case), and the same calculation performed with the new bias and uncertainty are compared below:

Original limiting Keff calculation (with WCAP-14416 bias and uncertainty applied):

$$Keff = (0.9361) + (0.0077) + \sqrt{0.00208^2 + 0.0030^2} = 0.94745$$

Revised limiting Keff calculation (with bias and uncertainty from Table 2 benchmark cases applied):

$$Keff = (0.9361) + (0.0011) + \sqrt{0.00208^2 + 0.0071^2} = 0.94460$$

Conclusion

The above results confirm that the combined effect of applying the WCAP-14416 code bias and bias uncertainty results in larger more conservative Keff values, when compared to a bias and bias uncertainty developed based on the NUREG/CR-6698 area of applicability criteria. Both Keff values remain below the limiting value of 0.95. Therefore, FENOC and Westinghouse have concluded that the benchmark performed in WCAP-14416 is conservative and that the Beaver Valley Unit 2 Fresh Fuel Rack Analysis meets the requirements of ANSI/ANS 8.1.

Table 2 –Benchmark Critical Experiments Performed for KENO-Va that meet the requirements of NUREG/CR-6698

Critical Number	General Description	Enrichment (235U w/o)	Reflector	Separating Material	Soluble Boron (ppm)	Measured Keff	KENO-VA Reactivity (Keff +/- One Sigma)
1	UO2 Rod Lattice	4.31%	Water	Stainless Steel	0	1.000	0.99063 +/- 0.00247
2	UO2 Rod Lattice	4.31%	Water	Water	0	1.000	0.98986 +/- 0.00228
3	UO2 Rod Lattice	4.31%	Water	Stainless Steel	0	1.000	1.00011 +/- 0.00248
4	UO2 Rod Lattice	4.31%	Water	Borated Aluminum	0	1.000	1.00070 +/- 0.00254
5	UO2 Rod Lattice	4.31%	Water	Borated Aluminum	0	1.000	1.00088 +/- 0.00253
6	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	0.99274 +/- 0.00235
7	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	1.00198 +/- 0.00262
8	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	1.00176 +/- 0.00253
9	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	1.00237 +/- 0.00256
10	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	1.00030 +/- 0.00236
11	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	1.00475 +/- 0.00254
12	UO2 Rod Lattice	5.06%	Water	Water	0	1.000	1.00078 +/- 0.00265

Average ΔK Bias = 0.0011

Bias Standard Deviation = 0.0026

95/95 Tolerance Factor = 2.736

95/95 Bias Uncertainty = 0.0071