M-53

Pacific Sierra Nuclear

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December 18, 1990
PSN-90-226

Mr. John P. Roberts
U.S. Nuclear Regulatory Commission
One White Flint North
11055 Rockville Pike
Rockville, MD 20852

Dear John:

Enclosed is the latest revision of the KENO-IV calculation package for the most reactive fuel and borated pool water. In summary, this package shows the following KENO-IV calculated results:

$\%^{235}U$	Boron ppm	KENO-IV calculated k	$+ 2\sigma$	$+ \Delta k_{calc}$	$+ \Delta k_{bias}$	$= k_{al}$
3.3	1800	0.9376	0.008	0.01	0.003	= 0.9586
3.3	2040	0.9343	0.006	0.01	0.003	= 0.9433
2.5	1080	0.9398	0.006	0.01	0.003	= 0.9588
4.2	2760	0.9228	0.008	0.01	0.003	= 0.9438

where

Δk_{bias} = code bias determined from comparison of calculation to critical experiments = 0.003

Δk_{calc} = sum of variations due to geometry (Δk_{geo}), water temperature (Δk_T), fuel homogenization (Δk_h.

Δk = variation due to geometry (assembly location within the storage sleeve) = 0.01 (determined from 3.3% fuel and 2040 wppm boron).

Δk_T = variation due to water temperature (70° to 212°F) = -0.004 so 0 was used for conservatism.

Δk_h = variation due to homogenization = -0.024 so 0 was used for conservatism.

These results were used to determine a Δk per 100 ppm of boron and this was used to determine the point on the graph of enrichment versus boron content to yield $k = 0.945$ (i.e., less than 0.95) and $k \leq 0.95$. This curve was put in the topical report as Figure 11.2-6.

As stated in our conversation of December 18, 1990, we originally estimated the k value for 5.0% enrichment. Since then, as part of our benchmarking and verification of KENO-V, we re-ran several problems and ran the 5.0% case. The results are shown below. The computer input and output is attached.

		KENO IV					KENO V					Difference KENO IV & KENO V
Enrichment	Boron wppm	k	2σ	Δk_{calc}	Δk_{bias}	Δk_{total}	k	2σ	Δk_{calc}	Δk_{bias}*	Δk_{total}*	
5.0	2820		-----extrapolated-----			0.9800	0.9810	0.0087	0.01	-0.002	0.9977	0.177

Similar differences were found between other KENO IV and KENO V comparisons for the 4.2% and 1.36% enriched cases (i.e., KENO V was always higher than or equal to KENO IV).

Our verification and benchmarking of KENO V is not complete (we need to run more criticals) but, as can be seen above, it compares very well (if anything, conservatively) with the KENO IV results. Therefore, we feel it is valid to examine and use the KENO V results for comparative purposes and to verify the boron concentration required at 5.0% ^{235}U.

We hope the above summary and the attached calculated package will provide you with the information you need. If you have any questions, please do not hesitate to call Mike Carr or myself.

Very truly yours,

John V. Massey, Ph.D.
General Manager

JVM:mao

Enclosure
cc: T. Albert, Science Applications
K. C. Leu, NRC
J. Stokely, SAIC

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* Preliminary value based on criticals ran to date. However, Idaho National Engineering Laboratory got -0.002 based in nine criticals. PSN is currently remodeling and running these and other B&W criticals. We are getting essentially (within statistical expectation) the same results.