ATTACHMENT 2 TO AEP:NRC:1071A

Proposed Revised

Technical Specification Page

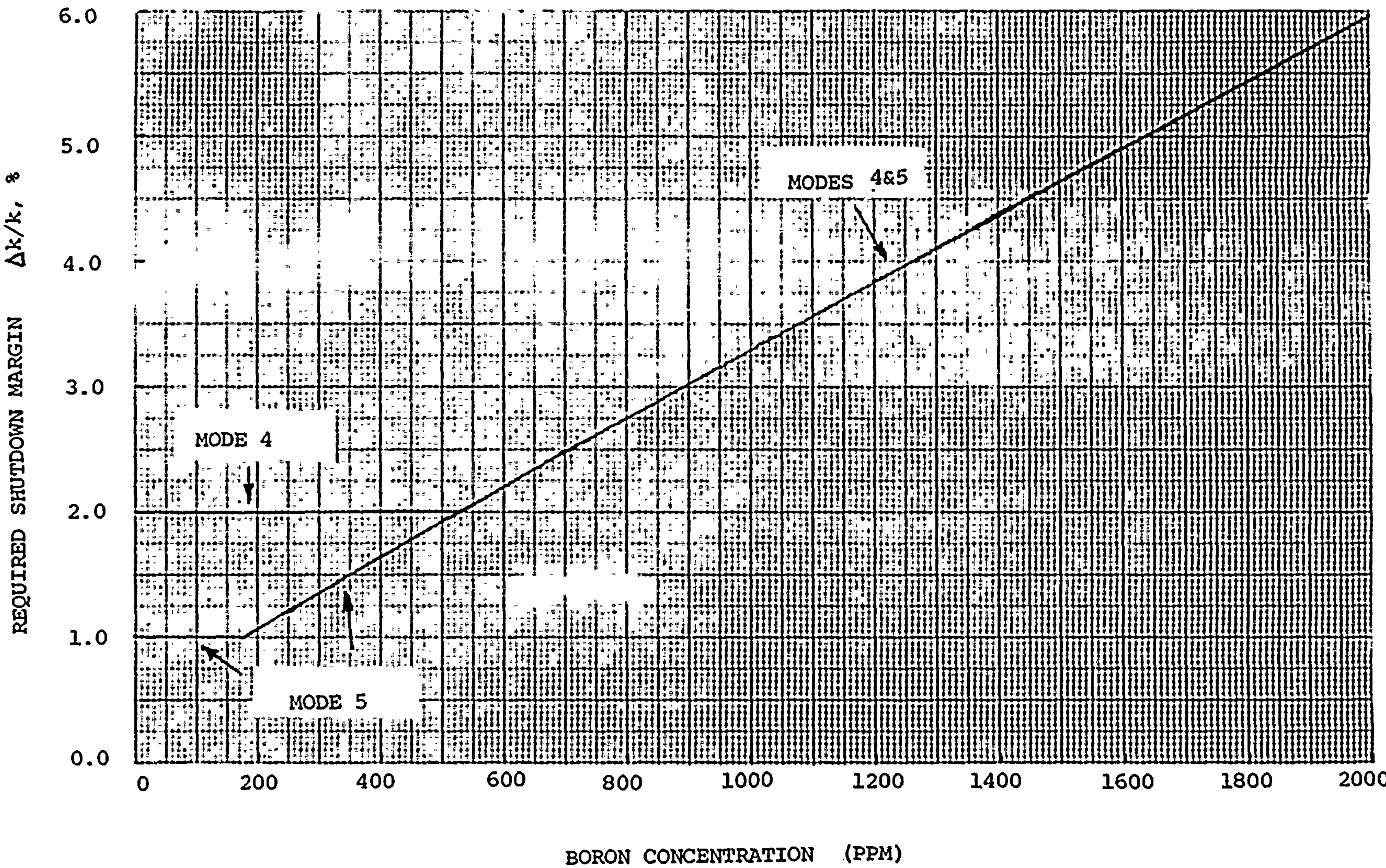

Figure 3.1-3 REQUIRED SHUTDOWN MARGIN

ATTACHMENT 3 TO AEP:NRC:1071A

Letter From ANF to I&MECo

Regarding a Non-Conservative Reactivity Evaluation

September 28, 1988
ANF-AEP/0667

Mr. Thomas Georgantis, Associate Engineer TAG 9/30/88
Nuclear Fuel & Analysis
Indiana Michigan Power Company
c/o American Electric Power Service Corp.
One Riverside Plaza, 20th Floor
Columbus, OH 43216-6631

Dear Mr. Georgantis:

Ref.: (1) XN-NF-85-64(P), Revision 2, Supplement 1, "Plant Transient Analysis for D.C. Cook Unit 2 With 10% Steam Generator Tube Plugging," (Boron Dilution Analysis) September 1986.
(2) XN-NF-86-63(P), Revision 1, "D. C. Cook Unit 2, Cycle 6 Startup and Operations Report," July 1986
(3) XN-NF-87-31(P), "Steam Line Break Analysis for D. C. Cook Unit 2," May 1987

Recent review of the boron dilution transient analysis (Ref. 1) for the D.C. Cook Unit 2, Cycle 7 Safety Analysis Report revealed that the equation used to estimate the required shutdown margin when using the residual heat removal system (RHR) in Modes 4 and 5 was incorrect. This equation was used to establish Figure 3.1-3 of the D.C. Cook Technical Specifications for Cycle 6. The shutdown margin for Modes 4 and 5 during RHR cooling is based on providing sufficient operator response time, 15 minutes, to terminate an asymmetric boron dilution event. An asymmetric boron dilution occurs when unborated water is assumed to flow into only one coolant loop.

A review of the Cycle 6 analyses indicated that there was sufficient conservatism in the Technical Specification curve and in the implementation of this requirement in the Startup and Operations Report (Ref. 2) to preclude criticality during a potential asymmetric boron dilution event. This conclusion is based on a comparison of Cycle 6 Modes 4 and 5 RHR shutdown margin boron concentration requirements specified in the Startup and Operations Report (Figure 6.2) and the critical boron concentrations. Both the shutdown margin and critical boron concentrations were calculated with the NRC approved XTGPWR code. The comparison indicated that sufficient shutdown boron concentrations were required to insure that the plant would not become critical in less than 15 minutes. Thus, the plant did not have the potential for operating in an unanalyzed condition during Cycle 6. A modification to Technical Specification Figure 3.1-3 is recommended for Cycle 7.

The equation used in the reference analysis to calculate the change in reactivity between the initial (shutdown) and final (critical) boron concentrations was,

$$\Delta\rho = (C_i)*\alpha_i - (C_f)*\alpha_f \text{ , where} \qquad \text{(Eq. 1)}$$

$\Delta\rho$ = change in reactivity (pcm)
C_i = the initial boron concentration (shutdown level)
α_i = the differential boron worth at the initial concentration, C_i,
C_f = the final boron concentration (critical level), and
α_f = the differential boron worth at the final concentration, C_f.

The correct equation to determine changes in reactivity from the boron dilution is,

$$\Delta\rho = [(C_i) - (C_f)] * (\alpha_i+\alpha_f)/2 \text{ , where} \qquad \text{(Eq. 2)}$$

$\Delta\rho$ = change in reactivity (pcm)
C_i = the initial boron concentration (shutdown level)
C_f = the final boron concentration (critical level),
α_i = the differential boron worth at concentration, C_i, and
α_f = the differential boron worth at concentration, C_f.

The reactivity changes from Eq. 2 are more accurate than those from Eq. 1 because of the definition of the differential boron worth. The differential boron worth used in the analysis is the worth of the next ppm of boron added at the current boron concentration. Thus, Eq. 2 is more accurate since it uses an average boron worth between the initial and critical boron concentrations. The boron worth required for Eq. 1 to be accurate is the average boron worth from 0 ppm to the initial and/or critical boron concentrations.

Although Eq. 2 will provide a more accurate estimate of the change in reactivity, several approximations still remain in using the differential boron worth data via Eq. 2. The most notable include the uncertainty in the calculated differential boron worth data and the limited calculational data from which the differential boron worth curve is constructed.

Because of these uncertainties, neutronic calculations were used to determine the required shutdown margin verses initial boron concentration and operating temperature. These calculations were performed with the NRC approved neutronics code, XTGPWR, which is ANF's standard neutronics code for performance of reload neutronics calculations. The difference between the Reference shutdown margin and the shutdown margin determined using the XTGPWR calculations for Cycle 6 is shown in Figure 1.

Calculations (XTGPWR) to determine the change in reactivity resulting from the 15 minute boron dilution were also performed for Cycle 7. While the results

for Cycles 6 and 7 are similar, the Cycle 6 results are conservative with respect to Cycle 7. A proposed Technical Specification Figure 3.1-3 is shown in Figure 2 and was obtained by conservatively adding 0.5 % ΔK/K to the calculated (XTGPWR) Cycle 6 shutdown values. This 0.5 % ΔK/K is included to cover cycle to cycle variations. Selected data points are presented in Table 1.

The requirements of Technical Specification Figure 3.1-3 are implemented conservatively through a curve of required boron concentration verses burnup. This curve was provided for D.C. Cook Unit 2 Cycle 6 in the Startup and Operations Report, XN-NF-86-63(P), Rev. 1. The magnitude of the conservatism in the required boron levels is seen from the curves presented in Figure 3. The curve labeled "Mode 4/5, Operation" is the required boron concentration verses burnup for plant operation in Modes 4 and 5 (from Ref. 2). The curves labeled "Mode 4/5, Dilution" and "Mode 4/5, Critical" compare the boron concentration after 15 minutes dilution to the critical boron concentration. From the figure, it is seen that sufficient boron is available at all boron concentrations to preclude criticality during a potential Boron Dilution event.

If you have any questions or comments regarding the above, please feel free to contact us.

Sincerely,

H. G. Shaw
Contract Administrator

cc: D. H. Malin
V. VanderBurg
D. L. Maxwell

Table 1 Revised Shutdown Margin for Modes 4 and 5 in RHR cooling

Boron Concentration (ppm)	Mode 4* (%Δk/k)	Mode 5 (%Δk/k)
0.0	2.00	1.00
175.0	2.00	1.00
400.0	2.00	1.65
525.0	2.00	2.00
800.0	2.76	2.76
1200.0	3.84	3.84
1600.0	4.92	4.92
2000.0	5.97	5.97

* The minimum required shutdown margin is based on the shutdown margin required by the steamline break analysis (Ref. 3)

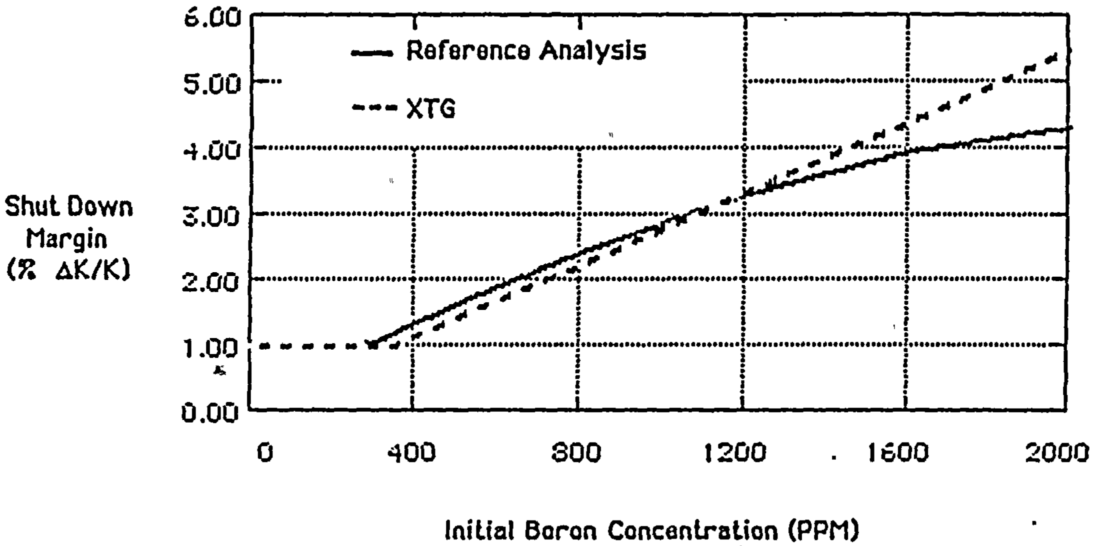

Figure 1 Shutdown Margin Comparison from Reference Analysis and XTG Approximation (Cycle 6)

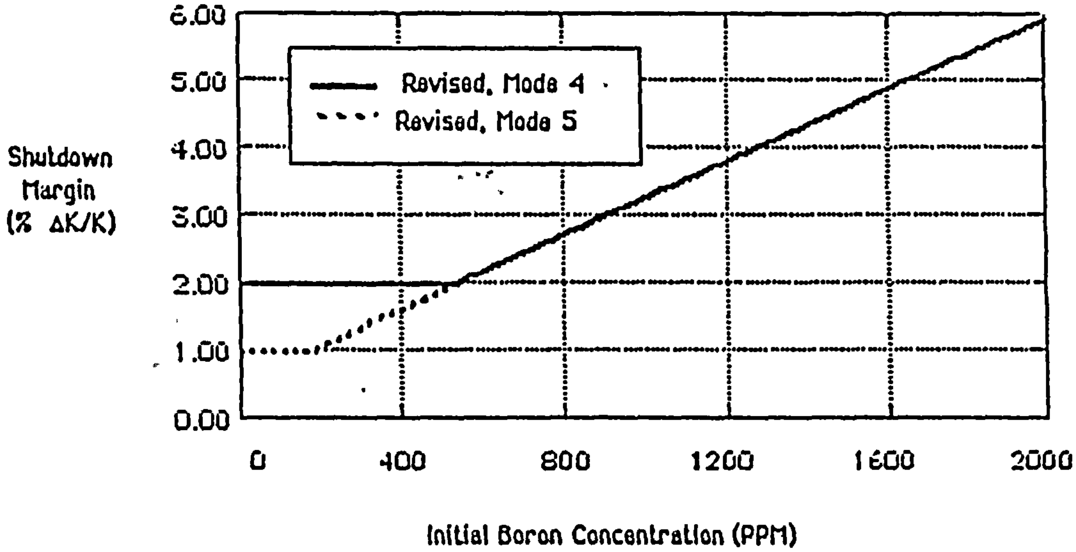

Figure 2 Revised Boron Shutdown Margin Requirement

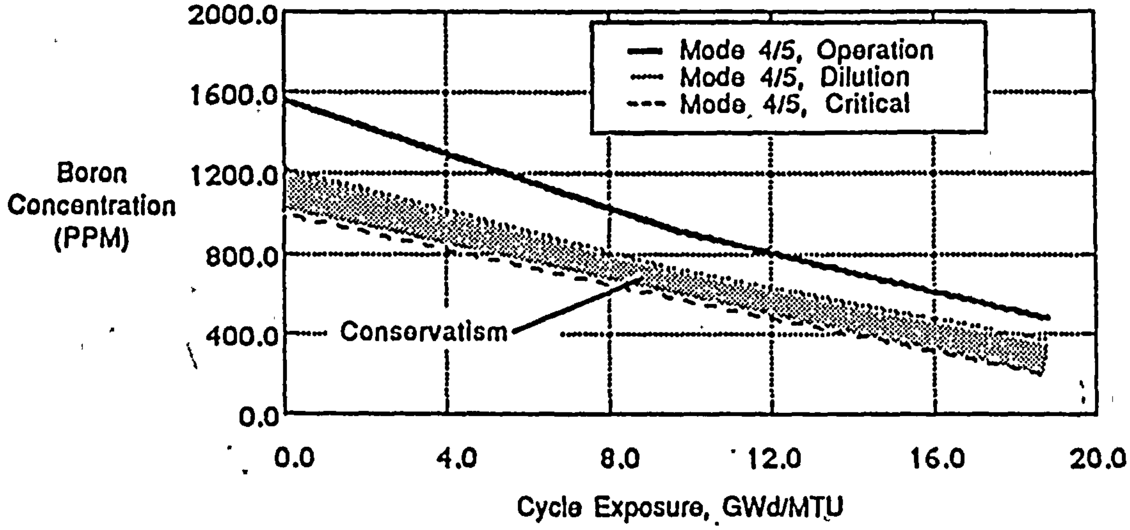

Figure 3 Conservatism in Operating Boron Requirement