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March 24, 1980

GFO:060:80

Mr. Thomas A. Ippolito
Operating Reactors Branch #3
Division of Operating Reactors
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Ippolito:

This letter transmits responses to questions you asked regarding report XN-NF-75-27, Supplement 2, "Exxon Nuclear Company Neutronic Design Method for Pressurized Water Reactors," in your letter dated July 12, 1979.

Sincerely,

G. F. Owsley, Manager
Reload Fuel Licensing

GFO:gf
Attachment
 As noted

CC: Mr. L. I. Kopp (USNRC)

ANSWERS TO NRC QUESTIONS ON

XN-75-27 (SUPP. 2) - EXXON NUCLEAR

NEUTRONIC DESIGN METHODS FOR PWRs

Q.1) In the comparison of predicted and measured boron concentrations and control rod worths, what are the effects of inaccuracies in the boron titrations, non-equilibrium boron concentrations throughout the coolant, and variable B-10 isotopic content?

A.1) The use of data from a number of reactors, over several cycles, causes the effect of these inaccuracies to be treatable as random errors between measured and calculated critical boron concentrations. Thus the use of measured boron concentration data with no attempt to remove these inaccuracies tends to result in conservative estimates of the critical boron concentration predictive accuracy of the core modeling codes.

The control rod worths are determined with a reactivity computer and expressed in terms of % reactivity. The inaccuracies in the boron titrations, non-equilibrium boron concentrations throughout the coolant, and variable B-10 isotopic content have no effect on the control rod worth measurements.

Q.2) With regard to the burnable poison transition effects from Cycle 1 fuel, why are the microscopic cross section sets transferred? Do not the isotopic concentrations transferred from Cycle 1 to Cycle 2 determine the spectrum, using the XPOSE 295 group library, for properly weighting the cross section sets to be used for Cycle 2?

A.2) As discussed in Section 3.2, the assembly PDQ isotopic files were correctly transferred from Cycle 1 to Cycle 2, however, new microscopic cross section sets were developed for each fuel type (dependent on the number of burnable poisons present, burnup, and enrichment). These microscopic cross section sets, generated by

XPOSE, incorporate the properly weighted cross sections influenced by the isotopic concentrations produced in the presence of burnable poison rods. The microscopic cross section sets transferred from Cycle 1 to Cycle 2 are of fuel types not directly effected by the insertion or removal of burnable poison rods.

Q.3) Are problems similar to those in the burnable poison transition effects encountered due to spectrum changes associated with boron letdown and assemblies previously containing different control rod insertion levels from Cycle 1 to Cycle 2.

A.3) The spectrum effect of boron letdown and partial control rod insertion is less significant than the spectrum effect due to the presence of burnable poison rods. The spectral effect of boron on the microscopic cross section sets is taken into account in the XPOSE depletion model. This allows for a better estimate of the fast-to-thermal flux ratio influence on fuel cell cross sections. The cross section sets do not incorporate the influence due to fractional control rod insertion. The effect is estimated to be minimal due to the present very limited utilization of control rods in the routine operation of PWR's. In addition the operating control bank(s) only affect a small fraction of the total number of fuel assemblies at partial to full power operation (< ten (10) assemblies).

Q.4) Can a value be estimated for the 95/95 confidence limit for power distribution and control rod worth measurements?

A.4) The 95/95 confidence limit for power distribution measurements has been evaluated in the "Exxon Nuclear Analysis of Power Distribution Measurement Uncertainty for Westinghouse PWR's", XN-NF-79-6 (P) dated July 1979. This report has been submitted to the NRC staff for review. It is reported that there is a 95% probability that the power distribution will not exceed 1.034 (3.40%) times the measured value at a 95% confidence level. A similar value could be determined for control rod worth measurements. The present ±10% uncertainty associated with calculated control rod worths is adequate to assure the safe operation of the plant.

Q.5) Do the control rod worth calculations include feedback effects? What is the effect of neglecting thermal-hydraulic feedback on the worth of control rods particularly at partial or full power conditions?

A.5) All control rod worth calculations at partial or full power conditions include thermal-hydraulic feedback effects. The effect of neglecting the thermal-hydraulic effect would be to cause a shift in the radial and axial power distributions resulting in inaccurate estimates of control rod worths.

Q.6) It appears that the revised procedure for determining power-to-activation rate ratios based on XPIN uses a supercell method and does not take into account the different flux gradie.ts due to spatial position of the fuel assemblies in the core. The previous PDQ calculations did since they were based on a 1/4 core configuration. What is the effect of neglecting the spatial location of the fuel assemblies in calculating the power-to-activation rate ratios?

A.6) The revised procedure does take into account the different flux gradients due to spatial position of the fuel assemblies in the core. The XPIN supercell method provides a factor that is used to adjust the thermal PDQ instrument flux. The flux gradients due to spatial position of the fuel assembly are preserved by the use of ϕ_1, and ϕ_2 from PDQ (see equation 6). The resultant activation rate (A_{cj}) and power-to-activation ratio (W_j) account for the flux gradients.

Q.7) The following typographical errors were found:

a) The group subscripts are missing from Eq. (2) on pg. 88.

b) The second τ_{1j} in Eq. (3) on pg. 89 should be replaced by ϕ_{1j}.

c) Pages 94 and 95 are reversed.

A.7) The typographical errors have been noted.