UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO APPROVAL OF TOPICAL REPORT EMF-96-051(P),

"APPLICATION OF THE ANFB CRITICAL POWER CORRELATION TO

CORESIDENT GE FUEL FOR QUAD CITIES UNIT 2 CYCLE 15

COMMONWEALTH EDISON COMPANY

AND

MIDAMERICAN ENERGY COMPANY

QUAD CITIES NUCLEAR POWER STATION, UNIT 2

DOCKET NO. 50-265

1.0 INTRODUCTION

By letter dated July 2, 1996 (Reference 1), as supplemented by letter dated February 17, 1997 (Reference 2), Commonwealth Edison Company (ComEd, the licensee) transmitted topical report EMF-96-051(P), "Application of the ANFB Critical Power Correlation to Coresident GE Fuel for Quad Cities Unit 2 Cycle 15" (Reference 3). The purpose of the submittals is to justify the applicability of the ANFB critical power correlation to coresident General Electric (GE) fuel to support ComEd's Siemens Power Corporation (SPC) transition reload for Quad Cities, Unit 2, Cycle 15 (QC2C15).

Due to the limitations imposed in the approved ANFB Critical Power Correlation (ANF-1125(P)(A) and its Supplements 1 and 2) and the findings in the inspection of the application of ANFB to ATRIUM-9 at SPC in February 1997, SPC has submitted a generic topical report, ANF-1125(P), Supplement 1, Appendix D, which is under staff review, for the future reload analysis in the safety limit minimum critical power ratio (MCPR) calculation.

2.0 EVALUATION

The QC2C15 core consists of 216 fresh fuel assemblies of SPC ATRIUM-9B and previously exposed GE fuel types (144 GE10 once burned assemblies, 144 twice, 152 thrice and 68 four-times burned GE9B assemblies). ComEd will use the ANFB critical power correlation (Reference 4) to establish and monitor MCPR limits for both SPC fuel and the coresident GE fuel (GE9/GE10) for QC2C15 operation.

For the ANFB correlation, the critical power is based on assembly hydraulic conditions and on local power peaking above each rod. The local power peaking dependency is characterized by the F-eff parameter which includes a component

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referred to as the additive constant. Additive constants are used to address effects on critical power performance due to different design features between assembly types and are determined based on the test data (Reference 5). The uncertainties in the additive constants are used in the MCPR safety limit methodology (Reference 6) to ensure that no more than 0.1 percent of the fuel rods are in boiling transition during anticipated operational occurrences (AOO).

The ANFB critical power correlation includes test results for many different fuel designs in its database; including fuel from other vendors. However, the coresident GE fuel, GE9B and GE10, in the transition QC2C15 core is not part of the existing database. An alternate process was proposed in References 3 and 5 to establish the additive constants and uncertainty using the approved methodology in Reference 4. The justification for this alternate process is based on the following: (1) development of GE9 additive constant; (2) derivation of GE9 additive constant uncertainty; (3) impact of the additive constant on safety analysis; and (4) MCPR margin for GE9/10 fuel in QC2C15.

2.1 Development of GE9 Additive Constant

Data specifically for Quad Cities GE9 fuel are not contained in the ANFB critical power correlation measured database. Therefore, additive constants for GE9 fuel are developed based on calculated critical power data obtained by ComEd from an approved critical power correlation based on test data applicable to the coresident fuel (References 3 and 5). Thus, critical power values, as a function of input conditions (i.e., flow, inlet subcooling, pressure, power, etc.) are created for the coresident fuel. These critical power values are analogous to the critical power data obtained for the SPC fuel types by test. The calculated critical power data is then used to establish the appropriate additive constants using the procedures described in Reference 4. An initial set of additive constants was used to determine nodal F-eff values for use with the ANFB correlation. Single assembly CPR calculations using the SPC plant simulator code MICROBURN-B were performed for fuel assemblies with power, exposure, inlet enthalpy, pressure, and active channel flow conditions consistent with the calculated data provided by ComEd. The results of the analyses (Reference 3) indicate that ANFB calculated CPR is lower than the corresponding GEXL calculated CPR, which indicates that applying the ANFB correlation is conservative since the ANFB correlation would put the fuel assembly closer to the MCPR safety limit.

2.2 Derivation of GE9 Additive Constant Uncertainty

The uncertainty (standard deviation) for the additive constants is required to establish MCPR limits. The method to determine the additive constants is described in Section 2.1 of this Safety Evaluation (SE). The additive constant uncertainty is determined directly by comparing ANFB predictions to test data for fuel types in the ANFB database and the additive constants for GE9 are established by a comparison to correlation instead of a direct comparison to data and an additional uncertainty is introduced. By combining these two uncertainties, the determination of the standard deviation uncertainty will lead to an uncertainty value larger than would be obtained if the ANFB correlation were compared directly to the critical power fuel test data for coresident GE9 fuel. Consequently, standard deviation when used as described in Reference 5 will result in the coresident fuel treated in a manner that results in conservative predictions of the safety margin to actual boiling transition.

2.3 Impact of Additive Constant on Safety Analyses

SPC will perform safety analyses to establish MCPR operating limits for the GE fuel present in the Quad Cities transition cycles. The additive constants will be used with the ANFB correlation to monitor the GE9/10 fuel. The MCPR operating limit for GE9/10 fuel at Quad Cities will be established by adding the ΔCPR for the limiting event to the MCPR safety limit for the cycle.

In the MCPR safety limit analysis, the core power is increased until the MCPR safety limit is reached for the limiting fuel assembly. Monte Carlo calculations are performed to assess the impact of the uncertainties of various plant and analysis parameters. The uncertainties considered include those for additive constants. The Monte Carlo calculations establish the MCPR safety limit at which 99.9 percent of the fuel rods are not in boiling transition. The sensitivity analysis was performed using a previous MCPR safety limit analysis (Reference 6). The additive constant uncertainty was increased by a certain percent for all fuel types in the core and the results of this sensitivity analysis indicate that the MCPR safety limit would increase by about double percent of the assumed increased additive constant uncertainty in the core to protect 99.9 percent of the fuel rods in the core from boiling transition. Analyses by the licensee shows that because the limiting fuel assembly is forced to the safety limit, the contribution of additive constant is relatively insignificant in the overall determination of the safety limit.

The licensee pointed out in its submittal that the determined additive constants will be applied to the coresident fuel (GE9) that is or will be in its second cycle of exposure. Also, the MCPR safety limit will be performed at various exposures throughout the cycle to ensure a bounding safety limit for the cycle. Analysis shows that the MCPR safety limit is primarily controlled by high power first cycle fuel (especially at the end-of-cycle conditions where the safety limit is normally limiting), therefore, the QC2C15 core design safety limit is expected to be relatively insensitive to the additive constant uncertainty used for GE9/10 fuel and in many cases the additive constants will not have any effect on the safety limit. That is, the coresident fuel (GE9) in its second or higher cycle of operation will not contribute to the number of rods in boiling transition.

2.4 MCPR Margin for GE9/10 Fuel in QC2C15

Analyses by the licensee show that the coresident fuel (GE9/10) will have significant MCPR margin when compared to the fresh SPC fuel due to the lower power of once or twice burned GE fuel. This is particularly true at end of cycle where the transients are expected to be most limiting. Preliminary core loading data shows significant steady-state MCPR differences between SPC and GE9 fuel based on the approved correlation for each fuel type. MCPR differences (GE9 fuel MCPR - SPC fuel MCPR) range from approximately 2.2 percent (at the beginning-of-cycle (BOC)) to approximately 20 percent (at the end-of-cycle (EOC)) of the expected delta MCPR for the fresh fuel. The data also indicated that throughout the cycle and especially at EOC, the coresident GE9 fuel will have significantly greater initial MCPR margin to the safety limit than that for the SPC fuel. Consequently, the fact that the coresident fuel has undergone at least one cycle of burning, combined with the conservative method of developing additive constant uncertainties, ensures that the coresident GE9/10 fuel will be nonlimiting relative to the SPC fuel.

Based on our review, the staff agrees with the licensee's submitted analyses and responses to the RAI. Therefore, the subject submittal (Reference 3) is acceptable for QC2C15 application.

3.0 CONCLUSIONS

Based on the above evaluation, the staff has concluded that the licensee's submittal regarding EMF-96-051(P), "Application of the ANFB Critical Power Correlation to Coresident GE Fuel for Quad Cities Unit 2 Cycle 15" is acceptable since: (1) the application to QC2C15 of the method of developing additive constants for ANFB correlation application to GE9 fuel is conservative, and (2) analyses based on this application shows substantially greater MCPR margin for the coresident GE9 fuel in the QC2C15 reload core with fresh SPC fuel.

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4.0 REFERENCES

1. Letter from John B. Hosmer (ComEd) to USNRC, ComEd Response to NRC Staff Request for Additional Information (RAI) Regarding the Application of Siemens Power Corporation ANFB Critical Power Correlation to Coresident General Electric Fuel for LaSalle Unit 2 Cycle 8 and Quad Cities Unit 2 Cycle 15, dated July 2, 1996.

2. Letter from E. S. Kraft, Jr. (ComEd) to USNRC, ComEd Response to Request for Additional Information on Topical Report EMF-96-051(P), "Application of Siemens Power Corporation ANFB Critical Power Correlation to Coresident GE Fuel for Quad Cities Unit 2 Cycle 15," dated February 17, 1997.

3. EMF-96-051(P), "Application of the ANFB Critical Power Correlation to Coresident GE Fuel for Quad Cities Unit 2 Cycle 15," dated May 1996.

4. ANF-1125(P)(A); ANF-1125(P)(A), Supplement 1; ANF-1125(P)(A), Supplement 2; ANFB Critical Power Correlation; dated April 19, 1990.

5. EMF-1125(P), Supplement 1, Appendix C, ANFB Critical Power Correlation Application for Co-Resident Fuel, dated November 1995.

6. ANF-524(P)(A), Revision 2; ANF-524(P)(A), Revision 2, Supplement 1; ANF-524(P)(A), Supplement 2, Advanced Nuclear Fuels Corporation Critical Power Methodology for Boiling Water Reactors Advance Nuclear Fuels Corporation Critical Power Methodology for Analysis of Assembly Channel Bowing Effects, dated November 1990.