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

ENCLOSURE

SAFETY EVALUATION REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATING TO TOPICAL REPORT EMF-1125(P), SUPPLEMENT 1, APPENDIX C "ANFB CRITICAL POWER CORRELATION APPLICATION FOR CO-RESIDENT FUEL" SIEMENS POWER CORPORATION

1 BACKGROUND

This submittal (EMF-1125(P), Supplement 1) references the approved Advanced Nuclear Fuel Correlation (Reference 1) which uses additive constants to account for changes in the critical power performance due to changes in design features between assembly types. That is, these additive constants are used in the ANFB correlation when the correlation is utilized to calculate critical power performance for a reactor core loaded with mixed fuel assembles, (i.e., fuel assemblies from different vendors).

These additive constants are determined in accordance with the NRC approved procedure described in Reference 1. The uncertainties associated with these additive constants are then used in the approved Siemens Power Corporation (SPC) safety limit methodology for boiling water reactors (BWR) fuel designs. The approved methodology is used to ensure that less that 0.1 percent of the fuel rods are in boiling transition during steady-state operation and during anticipated operational occurrences.

In a reload situation where SPC is the fuel supplier for the upcoming cycle, the critical power characteristics of the co-resident fuel must be evaluated. Typically, the ANFB critical power correlation includes data for many fuel designs in its data base (fuel from different vendors). However, when the co-resident fuel type in question is not part of the existing data base, a process is needed to establish additive constants consistent with the ANFB safety evaluation Report (SER) requirements.

The additive constants for the co-resident fuel are developed by analysis. Typically, the licensee performs analyses using a series of input parameters, i.e., flow, inlet subcooling, pressure, power, etc. Then the fuel's critical power is calculated using the critical power correlation approved for the co-resident fuel. This leads to the generation of critical power values as a function of conditions for the co-resident fuel. The calculated critical power values are then used to establish the appropriate additive constants using the procedures described in Reference 1.

For SPC fuel, the uncertainty in the additive constants is determined directly by comparing ANFB predictions to actual fuel test data. For the co-resident fuel that is not part of the ANFB data base, the additive constants are developed based on calculated critical power data obtained by using the critical power correlation approved for the co-resident fuel. Consequently, two uncertainties (standard deviations) must be combined, a) the ANFB correlation to co-resident fuel correlation uncertainty and b) the co-resident fuel correlation to data uncertainty. EMF-1125(P) Supplement 1, includes the

definitions and the procedure for combining these additive constants and provides a demonstration of the conservative approach taken by SPC.

In addition to this method of determining additive constants, the co-resident fuel will typically be in its second or higher cycle of operation. As a result, the co-resident fuel has an inherently greater minimum critical power ratio (MCPR) margin than the SPC fuel. This greater MCPR margin when combined with the method of developing the uncertainties associated with the additive constants for the co-resident fuel, will ensure that the co-resident fuel will always be non-limiting relative to the SPC fuel.

2 TECHNICAL EVALUATION

As mentioned above, when the co-resident fuel is not contained in the ANFB critical power data base, additive constants must be determined based on a statistical characterization of a correlation method approved for the co-resident fuel type (References 3 and 4). Extensive changes were made to the methodology as described in Reference 3, which detailed the statistical square root sum of the squares (SRSS) methodology. Reference 4 documents the changes made to this approach. Reference 4 should be incorporated in the (A) version of EMF-1125 (P) Supplement 1.

To establish the appropriate additive constants, SPC and the Utility jointly establish input conditions. These input parameters cover the ranges of pressure, mass velocity, inlet cooling, etc., consistent with expected operating and accident conditions. The licensee uses the co-resident critical power correlation to generate critical power values consistent with the input conditions. SPC then treats these critical power values and the corresponding input conditions in the same manner as test data.

The next step in the development of this statistical method is to determine the standard deviation associated with the development of the additive constants. This deviation stems from the fact that the additive constants are established by comparison of the co-resident fuel correlation to the resident fuel correlation, instead of a direct comparison of the resident correlation to the co-resident fuel data which is usually not available to the resident fuel vendor. This additional uncertainty must be combined with the correlation to test data uncertainty. This is the first component of the determination of the total standard deviation.

The second component of the uncertainty is the standard deviation of the co-resident fuel correlation to data. This standard deviation is provided by the licensee. The final step is to combine the individual components and arrive at a combined additive constant standard deviation for use in the approved safety limit methodology (Reference 5).

Consequently, when this total standard deviation is used in the approved SPC safety limit methodology, the co-resident fuel will be purposely restricted, resulting in more margin to actual boiling transition (Reference 5).

3 IMPACT ON THE SAFETY LIMIT

SPC conducted a sensitivity analysis of the impact of the increased (total) standard deviation of the additive constants on the MCPR safety limit. In the SPC approved safety limit methodology (Ref. 5), the power of the limiting assembly is raised until the assembly's critical power limit is reached. Then a Monte Carlo calculation is performed to assess the impact of the uncertainties of the various plant and analyses parameters. Included in these uncertainties are those uncertainties associated with the additive constants.

Monte Carlo calculations were performed to establish the MCPR safety limit at which 99.9 percent of the fuel rods are NOT in boiling transition.

The results of the sensitivity analysis indicated that the MCPR safety limit would increase by about twice the incremental increase in the additive constant uncertainty. Thus, there is a significant conservatism introduced for the co-resident fuel using the additive constant uncertainty generation process as described in Section 2.0 of this SER.

SPC pointed out that, generally, the process of generating additive constants and their associated uncertainties for the co-resident fuel will be applied only to fuel which is at least once burned fuel. Also, because the MCPR safety limit is primarily controlled by first cycle fuel, the actual impact of using the additive constants method will be more conservative than that obtained from the sensitivity study and in many cases will not result in an increase in the safety limit.

Typically, both the MCPR safety limit and the transient CPR response are most limiting near end of cycle (EOC). Also, because the MCPR operating limit for the entire cycle is based on EOC conditions, SPC analysis has shown that significant margin exists to the safety limit for both the SPC and co-resident fuel during transients earlier in the cycle. The analysis also indicate that over most of the cycle, and at EOC conditions where minimum margin to the safety limit occurs, the co-resident fuel will have more margin to its MCPR operating limit than the SPC fuel. Furthermore, the analysis showed that at EOC conditions, the co-resident fuel is not likely to contribute to the number of fuel rods calculated to be in boiling transition when the core is at the MCPR safety limit. The inherent MCPR margin (due mainly to the fact that it is once burned fuel) of the co-resident fuel, combined with the conservative method of developing additive constant uncertainties, ensures that the co-resident fuel will be non-limiting relative to the SPC fuel. MCPR data (tables, graphs etc.) comparisons, provided by individual licensee, confirms the additional safety margin associated with the once burned (co-resident) fuel. That is, the co-resident fuel will have more margin to boiling transition during potential transients.

4 CONCLUSION

The staff has reviewed the analyses in Topical Report EMF-1125(P), "ANFB Critical Power Correlation Application for Co-Resident Fuel," and concluded that they are acceptable for licensing applications, as per Siemen's agreement, subject to the following conditions:

1. This methodology (as described in this submittal, (Reference 1)) is applicable to once burned co-resident fuel. Lead assemblies are excluded.

2. A table comparing MCPR data throughout the first reload exposure must be submitted to justify each plant application.

5 REFERENCES

1. Letter, R.A. Copeland, submitting Topical Report EMF-1125(P) to the U.S. Nuclear Regulatory Commission, November 30, 1995.

2. ANF-1125(A) and Supplements 1 and 2, "ANFB Critical-Power Correlation," Advanced Nuclear Fuels Corporation, April 1990.

3. Letter, R.A. Copeland to R.B. Madcuff, "Combining of errors, EMF 1125(P), Supplement, Appendix C," November 15, 1995.

4. Letter, R.A. Copeland, documenting several changes to the methodology to incorporate additional conservatism, to the U.S. Nuclear Regulatory Commission, November 22, 1996.

5. ENF-524(P)(A) Revision 2 and Supplement 1 Revision 2 and Supplement 2 "Advanced Nuclear Fuels Corporation Critical Power Methodology for Boiling Reactors, Advanced Nuclear Fuels Corporation Critical Power Methodology for boiling Water Reactors: Metnodology for analysis of Assembly Channel Bowing Effects," November 1990.