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

SAFETY EVALUATION FOR THE GEXL CORRELATION APPLICATION TO 8x8R FUEL PER THE APPENDIX D SUBMITTALS OF THE GENERAL ELECTRIC TOPICAL REPORT, NEDE-24011-P-A, DATED FEB. 28, 1979 AND DEC. 14, 1979 CORE PERFORMANCE BRANCH

1. Background

The basic code in the GETAB transient analysis is the SCAT code (Ref. 1), which incorporates the GEXL correlation (Ref. 2) for predicting the change in bundle critical power ratio (CPR) during the transient.

The staff, in our evaluation of the General Electric Generic Reload Fuel Application (NEDE-24011-P) (Ref. 3) stated that future BWR core reload applications involving retrofit 8x8 fuel (8x8R) for a second operating cycle would have to include additional information which adequately justified the GEXL correlation for application to 8x8R fuel operating beyond one cycle. The licensee responded to our request in Cooper Nuclear Station Unit 1 Reload 5 submittal by referencing information (Ref. 4) furnished to the staff by GE which references a report (Ref. 5) prepared by GE on this same subject.

Reference 5 provides the results of full scale critical power tests performed on 8x8R fuel bundles. The tests, which included both transient and steady-state simulations, followed the same approved procedures (Ref. 2) used for the standard 8x8 (single water rod) and 7x7 (all fueled rods) fuel designs. The analysis of a total of 577 steady-state data points was performed using methods also previously approved by the staff. The data, involving nine test assemblies which spanned a range of local power peaking and flow conditions, showed according to GE, that the GEXL correlation was applicable to the retrofit fuel if adjustments were made to the additive constants used in the formulation of the rod-by-rod R-factors. The local power peaking dependent R-factors, used by the GEXL correlation to evaluate 8x8R bundle critical power, are based on the new additive constants shown in Figure 3-1 of Reference (Ref. 5). The value of the κ-factor is a function of bundle geometry, local peaking, rod position, and fuel spacer effects. In any fuel bundle the rod with the greatest R-factor is designated the limiting rod and that R-factor is used in the GEXL correlation to evaluate the thermal performance for the bundle.

Using the new R-factors, GE performed a data analysis to assess the accuracy and precision of the GEXL correlation. The results of this analysis showed that the correlation fit provides for a mean predicted-to-measured critical power ratio of 0.9879 with a standard deviation of 0.0234. The staff has obtained an independent analysis, using COBRA-IV-I code incorporated with GEXL correlation, which resulted in a mean predicted-to-measured critical power ratio of .932 with a standard deviation of .0395, which is conservative in comparison to the GE analysis.

The staff has reviewed the test data base (Ref. 4 & 5) provided by GE to support the GEXL correlation used for determining the safety limit MCPR for BWR cores incorporating retrofit 8x8 fuel design. In our review, we found what appeared to be a nonconservative bias, which the staff believed to be related to the 8x8R fuel having high rod-to-rod radial power peaking and possibly associated with the sub-channel heat flux (See Ref. 5, Figures 3-2, 3-4

3-5 and 3-6). The 8x8R data were obtained from tests having cosine power shape, which provided conservative data during testing of regular 8x8 bundles. Since the cause of the data bias for some tests was not clear the statistics relating the non-conservative data to certain operating conditions or operating cycles were also not clear. Clarification was requested on how the selection of rod-to-rod power patterns for bundle CHF testing was performed to provide assurance that the most severe power patterns were represented by the test bundles.

2. Conclusion

In response to our concerns (Ref. 6), the General Electric Company made a presentation (Ref. 7) to the staff in Bethesda, Maryland on August 19, 1980.

In the August presentation it was demonstrated by a comparison of test assembly and production fuel that the test assemblies used in the 8x8R ATLAS test were representative of the higher (limiting) R-factor standard production GE BWR fuel bundles and by a statistical method of analyzing Experimental Critical Power Ratio (ECPR) data that the variability of data was such that an unfavorable test prediction for one bundle is not regarded as GEXL bias for that bundle type, but rather as a random value about the overall mean prediction which would not be repeated exactly for other bundles, even of the same type.

The staff has also performed an independent analysis with the normal 8x8 and the 8x8R forms of the GEXL correlation for the Atlas 8x8R fuel test data, using COBRA-IV-I, and has found as follows:

1) The differences between the results calculated using the GEXL correlation with 8x8 additive ℓ constants and with 8x8R additive ℓ constants in the R-factor are, on the average, less than 0.5%.
2) The limiting CPR values for the two forms of the correlation, with a probability of 99% of not experiencing boiling transition, are within 3% of each other; 1.067 and 1.032.
3) For this data set (Ref. 5), the distribution of the CPR values calculated with the 8x8R additive constants is normal, and there is no evidence of any particular bias in this form of the correlation.

Based on the results of the staff's independent analysis and the GE presentation, we have concluded that the GEXL correlation is acceptable for 8x8R fuel application and that the Appendix D submittals of the General Electric Topical Report, NEDE-24011-P-A, dated Feb. 28, 1979 (Ref. 8) and Dec. 14, 1979 (Ref. 9) are acceptable for incorporation into that document.

Before the staff will approve the application of GEXL to any new fuel types, we will require that the test data base include sufficient repetition of tests at the same test conditions to identify data scatter due to measurement uncertainties and lack of repeatability versus any bias that may exist as a function of variation in test parameters.

REFERENCES

1. "Analytical Model for Loss of Coolant Analysis in Accordance with 10 CFR 50, Appendix K," NEDE-20566-P, January 1976.
2. "General Electric Thermal Analysis Basis Data, Correlation and Design Application," NEDO-10958, November 1973.
3. Letter, D. G. Eisenhut (NRC) to R. Gridley (GE), "Safety Evaluation for the General Electric Topical Report NEDE-24011-P, Generic Reload Fuel Application," May 12, 1978.
4. Letter, R. Engle (GE) to D. G. Eisenhut and R. Tedesco (NRC), "Additional Information 8x8R Fuel GETAB R-factors," March 30, 1979.
5. Letter, R. Gridley (GE) to D. G. Eisenhut and D. Ross (NRC), "General Electric Information NEDE-24131, Basis for 8x8 Retrofit Fuel Thermal Analysis Application," October 5, 1978.
6. Letter, L. S. Rubenstein (NRC) to G. G. Sherwood (GE), July 28, 1980.
7. Letter, R. Engle (GE) to L. S. Rubenstein (NRC), "Response to NRC Concerns on the 8x8R GEXL Correlation," August 26, 1980.
8. Letter, J. F. Quirk (GE) to O. D. Parr (NRC), "General Electric Licensing Topical Report NEDE-24011-P-A, Generic Reload Fuel Application, Appendix D Second Submittal," February 28, 1979.
9. Letter, R. E. Engel (GE) to T. A. Ippolito (NRC), "General Electric Licensing Topical Report NEDE-24011-P-A, Generic Reload Fuel Application Appendix D Submittal," December 14, 1979.

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