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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
MODERATOR TEMPERATURE COEFFICIENT, LER 269/86-006
OCONEE NUCLEAR STATION, UNIT NO. 1
DUKE POWER COMPANY
DOCKET NO. 50-269

1.0 INTRODUCTION

By letter dated May 12, 1986, Duke Power Company (DPC) submitted a Licensee Event Report (LER) No. 269/86-006 (Ref. 1). This LER reports the results of a measurement which indicated that the end of cycle (EOC) moderator temperature coefficient (MTC) was more negative than assumed in the safety analysis for Oconee, Unit 1, Cycle 9. The staff has reviewed the LER, information submitted by DPC by letter dated April 23, 1986 (Ref. 2), pertinent sections of the FSAR, and information received in a telephone conference call on June 20, 1986.

MTC is the change in reactivity that results from a change in the temperature of the water in the core. It is measured in units of $\Delta\rho/\Delta T$, or a change in reactivity per degree Fahrenheit change in the average moderator temperature. For power excursion transients, the more negative MTC is desirable. That is not the case for overcooling accidents. As the assumed MTC becomes more negative, added positive reactivity feedback occurs from primary system overcooling. A more negative MTC raises the potential that the core could achieve recriticality during the transient.

2.0 BACKGROUND

On April 10, 1986 Duke Power Company (DPC), the licensee for Oconee Nuclear Power Station, Unit 1, concluded that the hot full power (HFP) moderator temperature coefficient (MTC) at the end of cycle (EOC) 9 was -3.36×10^{-4} $\Delta\rho/^{\circ}F$. This MTC was based on the analysis of measured data taken on February 10, 1986 with the reactor at 98% of full rated power and at a soluble boron concentration of 46 parts per million (ppm). Since the MTC was more negative than the value of -3.0×10^{-4} $\Delta\rho/^{\circ}F$ assumed in the Cycle 9 safety analyses, it resulted in a condition outside of the design basis of the plant and, therefore, was reportable under the provisions of 10 CFR 50.72 and 10 CFR 50.73. The LER 269/86-006 was sent by DPC for Oconee, Unit 1 pursuant to these regulations.

No corrective actions were necessary for Cycle 9 because the end of Cycle 9 occurred on February 13, 1986 shortly after the measurements were taken. No accidents or transients occurred during the time that the HFP MTC was more negative than -3.0×10^{-4} $\Delta\rho/^{\circ}F$. Therefore, the public health and safety were not affected. DPC reported that no corrective actions were required for Oconee, Units 2 and 3 since these units were operating at cycle burnups and soluble boron concentrations which would not produce MTCs more negative than -3.0×10^{-4} $\Delta\rho/^{\circ}F$. However, an MTC measurement was performed on March 11, 1986 on Oconee, Unit 2 with the reactor at 274 effective full power days (EFPD) into Cycle 8. This measurement yielded a value for the MTC of -2.88×10^{-4} $\Delta\rho/^{\circ}F$.

3.0 EVALUATION

This measurement, along with the previous measurement for Oconee Unit 1, confirmed the non-conservatism in DPC's determination of MTCs for these extended cycle cores. DPC attributes this deficiency to a normalization of its MTC calculations to B&W's MTC calculations and of a lack of data to benchmark calculations in the applicable burnup range of the reactor cycle. DPC reported in the LER that it would remove this calculational bias in its MTC calculations. DPC states that additional measurements will be taken on an Oconee unit during a shutdown, due to whatever cause, which occurs after 300 EFPDs and leads to a xenon free core.

DPC reviewed the FSAR to determine the transients and accidents that would be adversely impacted by a more negative HFP EOC MTC. Four events were identified as requiring further evaluation (Ref. 2). These events are (1) the cold water accident (FSAR Section 15.5), (2) the control rod misalignment accidents (FSAR Section 15.7), (3) the rod ejection accident (FSAR Section 15.12), and (4) the steam line break accident (FSAR Section 15.13). DPC used the RETRAN 02-MOD003 computer code to calculate the system responses to the cold water accident and the control rod misalignment accident. The analyses used an MTC of -3.5×10^{-4} $\Delta\rho/^{\circ}F$. The results showed that the consequences of a cold water accident were more severe than the consequences with an MTC of -3.0×10^{-4} $\Delta\rho/^{\circ}F$. The consequences for the control rod misalignment accidents (a control rod drop accident was analyzed) were shown to be insensitive to the MTC.

Although RETRAN 02-MOD003 has been accepted by the staff, each utility using the code is required to submit its own plant specific application justifying the use of the code. This has not been done by DPC. However, the use of the code by DPC to determine the system responses for the two events described above is acceptable for the purpose of evaluating the safety significance of having been outside of the design basis of the Oconee, Unit 1 safety analysis near EOC 9 with the more negative MTC.

DPC reevaluated the results for the rod ejection accident analysis presented in the FSAR. These results show that a more negative MTC would not increase the consequences of a control rod ejection accident. In its review of the information presented in the FSAR, DPC states that the HFP MTC is not controlling regarding the shutdown margin because its core design methodology requires at least a 1% $\Delta k/k$ shutdown margin at hot zero power (HZP). In fact, DPC states that, in practice, the actual EOC shutdown margin exceeds the required 1% $\Delta k/k$ margin. For moderator cool-down below 532°F, DPC will use the HZP MTC as being the applicable MTC rather than the HFP MTC that evidently was used in the FSAR analysis.

In a telephone conference call with the staff on June 20, 1986, DPC stated that the MTC used in deriving the normal operating power-imbalance envelope was based on an MTC inherent in the nodal code calculations. The MTC obtained with the nodal code (and not normalized to the B&W MTCs) apparently yields acceptable values of the MTC when compared to the measured data. Therefore, since the nodal code MTCs were used in deriving the power-imbalance envelope, the more negative measured EOC MTC did not affect these limits.

4.0 CONCLUSIONS

Based on its review, the staff concurs with the DPC assessment, actions taken, or to be taken concerning the more negative MTC than assumed in the safety analyses for EOC 9 for Oconee, Unit 1. In particular, the assessment showed that the four FSAR events that were impacted all remained within their respective safety criteria. In addition, DPC will design reload Oconee cores such that the HFP MTC will be no more negative than -3.5×10^{-4} $\Delta\rho/^{\circ}F$ and the HZP MTC will be no more negative than -3.0×10^{-4} $\Delta\rho/^{\circ}F$. Finally, DPC will perform MTC measurements as opportunities become available in the Oconee Units.

5.0 REFERENCES

1. LER 269/86-006 Oconee Unit 1 Cycle 9 End of Cycle Hot Full Power Lower Moderator Temperature Coefficient, May 12, 1986.

2. Letter from H. B. Tucker (Duke Power Company) to H. R. Denton, (NRC), April 23, 1986.

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