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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 86 TO FACILITY OPERATING LICENSE NO. NPF-2

AND AMENDMENT NO. 80 TO FACILITY OPERATING LICENSE NO. NPF-8

ALABAMA POWER COMPANY

JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-348 AND 50-364

1.0 INTRODUCTION

By letter dated July 13, 1990 (reference 1), Alabama Power Company (APCo or the licensee) submitted an application to amend the Technical Specifications (TS) of the Joseph M. Farley Nuclear Plant (Farley), Units 1 and 2. The proposed changes would modify (1) the most negative moderator temperature coefficient (MTC) limiting condition for operation (LCO), (2) the associated surveillance requirements, and (3) the associated Bases. The purpose of this LCO and surveillance requirements is to ensure that the most negative MTC at end-of-cycle (EOC) remains within the bounds of the Farley, Units 1 and 2, safety analyses, in particular, for those transients and accidents that assume a constant value of the moderator density coefficient (MDC) of 0.43 delta/k per gm/cc.

Farley Technical Specification Surveillance Requirement 4.1.1.3.b involves an MTC measurement at any thermal power within 7 effective full power days (EFPD) after reaching an equilibrium primary coolant boron concentration of 300 ppm. After corrections are made, the measured value is compared to the hot full power surveillance requirement limit with all control rods out of the core. In the event that the measured MTC is more negative than the surveillance requirement limit, the MTC must be remeasured and compared with the EOC, MTC, LCO value at least once per 14 EFPD during the remainder of the cycle. The Farley, Units 1 and 2, LCO and surveillance requirement values in the TS for the most negative MTC are conservative (less negative) when compared to the value of the MTC corresponding to the MDC which is used in the safety analyses.

For the high discharge burnup cores used for Farley, Units 1 and 2, APCo anticipates that future measured values of MTC required near EOC may result in an MTC that will be more negative than the surveillance requirement limit. This will then require APCo to make MTC measurements once every 14 EFPD until the EOC. Failure to meet the surveillance requirements MTC does not necessarily mean that either the most negative

MTC that would occur near EOC would be exceeded or that the safety analysis MTC would be exceeded. APCo states that these additional MTC measurements, if needed to comply with the surveillance requirements, would be an undue burden to Farley, Units 1 and 2.

APCo proposes to change the LCO (3.1.1.3.b) most negative MTC value from -3.9×10^{-4} delta k/k/°F to -4.3×10^{-4} delta k/k/°F. Surveillance Requirement 4.1.1.3.b would be changed from -3.0×10^{-4} delta k/k/°F to -3.65×10^{-4} delta k/k/°F. These changes would remove about 0.25×10^{-4} delta k/k/°F from the difference between the surveillance requirements and the EOC, LCO, MTC values. These values would still be bounded by the Farley safety analysis values of the MTC of -5.1×10^{-4} delta k/k/°F, which is used for maximum negative reactivity feedback analyses. In addition, change is proposed to Surveillance Requirement 4.1.1.3.b to allow for suspension of extended measurements every 14 EFPD once the equilibrium boron concentration falls below 100 ppm provided the measured MTC value is less negative than -4.0×10^{-4} delta k/k/°F. These changes apply to the current and future reload cycles for Farley, Units 1 and 2, and are supported by an evaluation provided in a Westinghouse Electric Corporation (Westinghouse) report (reference 2) submitted with the amendment application.

2.0 EVALUATION

2.1 Methodology

The current method used to determine the most negative MTC is described in the Westinghouse Standard Technical Specifications (STS) in Bases Section 3/4.1.1.3 (reference 3). The method is based on incrementally correcting the conservative MDC used in the safety analysis to obtain the most negative MTC value or, equivalently, the most positive MDC at nominal hot full power core conditions. The corrections involve subtracting the incremental change in the MDC, which is associated with a core condition of all control rods inserted, to an all control rods out core condition. The MTC is then equal to the product of the MDC times the rate of change of moderator density with temperature at rated thermal power conditions. This STS method of determining the most negative MTC, LCO value results in an all control rods out MTC which is significantly less negative than the MTC used in the safety analysis and may even be less negative than the best estimate EOC all control rods out MTC for extended burnup reload cores. This has the potential for requiring the plant to be placed in a hot shutdown condition by TS 3.1.1.3 even though substantial margin to the safety analysis MDC exists. This problem with the current STS method is caused by adjusting the MDC from a hot full power all control rods inserted to a hot full power all control rods out condition in defining the most negative MTC. The hot full power all control rods inserted condition is not allowed by TS on control rod positions for allowable power operation in which the shutdown banks are completely withdrawn from the core and the control banks must meet rod insertion limits.

Reference 2 provides an alternative method for adjusting the safety analysis MDC to obtain a most negative MTC. This method is termed the most negative feasible MTC. The most negative feasible MTC method seeks to determine the conditions for which a core will exhibit the most negative MTC value that is consistent with operation allowed by the TS. For example, the most negative feasible MTC method would not require the conversion assumption of the all control rods inserted, hot full power condition, but would require the conversion assumption that all control rod banks are inserted the maximum amount that are permitted by the TS. Reference 2 uses the most negative feasible MTC method to determine EOC MTC sensitivities for those design and operational parameters that directly impact the MTC in such a way that the sensitivity to one parameter is independent of the assumed values for the other parameters. The parameters considered with this most negative feasible MTC method include:

(1) soluble boron concentration in the coolant
(2) moderator temperature and pressure
(3) control rod insertion
(4) axial power shape
(5) transient xenon concentration.

The most negative feasible MTC approach uses this sensitivity information to derive an EOC, all control rods out, hot full power, MTC, LCO value based on the safety analysis value of the MDC.

This most negative feasible MTC approach has, according to the licensee, a number of advantages over the previous method for determining the most negative MTC, LCO value. The most negative feasible MTC will be sufficiently negative so that repeated MTC measurements from a 300 ppm core condition to EOC would not be required. The most negative feasible MTC method does not change the safety analysis moderator feedback assumption. The safety analysis value of MDC is unchanged. The most negative feasible MTC method is a conservative and reasonable basis to assume for an MTC value of a reload core and is consistent with plant operation defined by other TS. Finally, the most negative feasible MTC method retains the surveillance requirement on MTC at the 300 ppm core condition to verify that the core is operating within the bounds of the safety analysis.

The licensee has determined the sensitivity of the above parameters on the EOC MTC for three different reload designs representative of future Farley, Units 1 and 2, reloads. These reload designs included fuel designs, discharge burnups, and cycle lengths which are typical of those expected for Farley, Units 1 and 2. The soluble boron concentration was not used in the sensitivity analysis because the EOC, hot full power, all control rods out, MTC, TS value is assumed to be at 0 ppm of boron, the definition of EOC, and because the most negative MTC occurs at 0 ppm of boron in the coolant.

The sensitivity study did not include the radial power distribution which can vary under normal operation and can affect the MTC. The operational activities that affect the radial power distribution do so through the movement of control rods and activities that affect the xenon concentration. The allowed changes in the radial power distribution are implicitly included in the MTC sensitivity to control rod insertion and xenon concentration.

The licensee states that the MTC surveillance requirement value would be obtained in the same manner as currently described in the STS Bases (reference 2). The MTC surveillance requirement value is obtained from the EOC, all control rods out, MTC value by making corrections for burnup and boron at a core condition of 300 ppm of boron.

The staff has reviewed the assumptions and basis for the most negative feasible MTC method described above and concludes that they are acceptable because (1) they will result in conservative, most negative, MTC, LCO and surveillance requirement values that could result from allowed operation of Farley, Units 1 and 2, from nominal conditions, and (2) the MTC measurement at 300 ppm of boron core condition will assure, using the MTC surveillance requirement value, that the safety analysis MDC will not be exceeded.

2.2 Farley, Units 1 and 2, Accident Analysis MDC Assumption

The licensee uses an MDC for performing accident analyses. For events sensitive to maximum negative moderator feedback, a constant value of the MDC of 0.43 delta k/gm/cc is assumed throughout the analysis. For hot full power and full flow nominal operating conditions, the temperature and pressure are 577.2°F and 2250 psia, respectively. At these conditions, the MTC equivalent to the MDC of 0.43 delta k/gm/cc is -5.1×10^{-4} delta k/k/°F. We will refer to this MTC as the safety analysis MTC. Based on its review, the staff concludes that the evaluation of the MTC from the MDC is acceptable because it conforms to the relationship of MTC to MDC; that is, the MTC is equal to the MDC times the rate of change of density with temperature at the nominal pressure and temperature of the coolant at rated thermal power conditions.

2.3 Sensitivity Results

Farley, Units 1 and 2, TS 3.2.5 provides the LCO values of the departure from nucleate boiling (DNB) parameters; reactor coolant system (RCS) average temperature (T_{avg}); and pressurizer pressure. The minimum allowable pressurizer pressure is 2220 psia and maximum allowable T_{avg} is 581.2 °F. These values of the minimum pressurizer pressure and maximum T_{avg} were also assumed for the safety analysis. The current nominal design T_{avg} for Farley, Units 1 and 2, is 575 °F so that the safety analysis represents a 6.2 °F maximum allowable increase in T_{avg} nominal conditions. The current nominal design pressure is 2250 psia so that the safety analysis represents a 30 psia maximum allowable decrease from nominal pressurizer pressure. Based on these maximum allowed system variations, a maximum allowable limit is placed on the moderator density variation. Using the sensitivity of the MTC to temperature and pressure, derived from the analysis of the three reload designs, a bounding delta MTC (a proprietary value) was obtained associated with these maximum allowable coolant temperature and pressure deviations from nominal conditions.

Farley, Units 1 and 2, TS 3.1.1.3 requires an all control rods out configuration in the evaluation of the MTC. TS 3.1.3.5 requires that all shutdown banks be withdrawn from the core during normal operation (Modes 1 and 2). TS 3.1.3.6 limits control bank insertion by rod insertion limits in Modes 1 and 2. All control rods can be inserted at hot zero power coincident with a reactor trip. In general, greater control rod insertion results in a more negative MTC assuming that all other parameters are held constant. However, greater control rod insertion will also cause a reduction in core power and T_{avg} which causes the MTC to become more positive. This effect is more pronounced at lower power with the positive change being more important than the negative change in the MTC. Based on this line of reasoning, the licensee determined that the most negative MTC configuration will occur at hot full power with control rods inserted to the rod insertion limits. The licensee analyzed three reload core designs, using a bounding value of control bank D insertion at hot full power with no soluble boron in the coolant. This analysis gave a bounding delta MTC (a proprietary value) associated with the control bank inserted to the rod insertion limits for Farley, Units 1 and 2.

The axial power shape produces changes in the MTC caused primarily by the rate at which the moderator is heated as it flows up the core, with the MTC sensitivity to extremes of axial power shapes being small. This effect can be correlated with the axial flux difference, which is the difference in the power in the top of the core minus the power in the lower half of the core. The TS for Farley, Units 1 and 2, include limits on the axial flux difference. The licensee determined that the more negative the axial flux difference, the more negative the MTC. The licensee analyzed three reload designs and determined the sensitivity of the MTC to axial flux difference. This analysis gave a bounding delta MTC (a proprietary value) for an assumed bounding value of axial flux difference.

Although no TS limits exist on either the xenon distribution or concentration, the axial xenon distribution is effectively limited by TS limits on the axial flux difference. The physics of the xenon buildup and decay process limits the xenon concentration. The effect of xenon axial distribution is quantified in the effect of the axial power shape on the MTC, as discussed previously. The effect of the overall xenon concentration on the MTC needs to be evaluated separately. The licensee determined that the MTC became more negative with no xenon in the core. Therefore, the licensee analyzed the three reload core designs at EOC, hot full power, all control rods out, with no xenon present. This analysis gave for Farley, Units 1 and 2, a delta MTC (a proprietary value) for the xenon concentration factor.

All of the delta MTC values described above are summed to provide a total delta MTC for Farley, Units 1 and 2, based on the allowed deviations of the various factors from nominal values.

The staff has reviewed the discussion and analysis of the primary factors of the most negative feasible MTC method and concludes that the results obtained are acceptable because approved methods and conservative assumptions were used to generate the results.

2.4 Farley, Units 1 and 2, EOC MTC TS Value

Using the total delta MTC obtained with the most negative feasible MTC method, the licensee determined that the Farley, Units 1 and 2, safety analysis MTC of -5.1×10^{-4} delta k/k/°F should be increased by the total delta MTC plus an additional amount for conservatism. The resulting EOC, hot full power, all control rods out, MTC for Farley, Units 1 and 2, is -4.3×10^{-4} delta k/k/°F. This value replaces the current TS value. Thus, determination that an MTC for the EOC, hot full power, all control rods out, reload core is less negative than -4.3×10^{-4} delta k/k/°F provides assurance that the safety analysis MTC remains bounding.

The licensee also performed an analysis to determine the surveillance requirement value of the all control rods out reload core at 300 ppm of boron. Analysis of reload cores similar to Farley, Units 1 and 2, future reload designs resulted in a conservative value of 0.65×10^{-4} delta k/k/°F to bound the expected difference in MTCs between the 300 ppm of boron core condition to EOC. Thus, the MTC surveillance requirement value is -3.65×10^{-4} delta k/k/°F compared to the present TS value for Farley, Units 1 and 2.

The staff has reviewed this determination of the most negative MTC LCO and surveillance requirement and concludes that they are acceptable.

2.5 Suspension of MTC Measurements Below 100 PPM

As stated earlier, if the measured MTC after reaching 300 ppm of boron is more negative than the surveillance requirement limit, the MTC must be remeasured and compared with the EOC, MTC, LCO value at least once every 14 EFPD during the remainder of the cycle. The licensee has proposed a note to Surveillance Requirement 4.1.1.3.b which would allow suspension of extended MTC measurement once the equilibrium boron concentration falls below 100 ppm, provided the last measured value is less negative than -4.0×10^{-4} delta k/k/°F. The slope of a line connecting this secondary surveillance criterion value with the 300 ppm surveillance requirement value of -3.65×10^{-4} delta k/k/°F is more characteristic of actual MTC behavior with core depletion and somewhat less steep than the slope of a line connecting the TS values. Projection of the line connecting the 300 ppm surveillance requirement value and this secondary surveillance criterion value to a boron concentration of 0 ppm (EOC) shows that margin exists to the EOC, LCO limit of -4.3×10^{-4} delta k/k/°F.

The staff finds this proposed change acceptable since it conservatively bounds the maximum change in MTC between the 100 ppm equilibrium boron concentration and the EOC, including the effects of boron concentration reduction, fuel depletion, and EOC coastdown and also eliminates several measurements near EOC which perturb reactor operation and generate large volumes of waste water.

2.6 Safety Analysis Impact of Most Negative Feasible Approach

Changes in the parameters discussed previously could take place during a transient to make the MTC more negative than allowed during normal operation. The most adverse conditions seen in the affected transient events will not result in a reactivity insertion that would invalidate the conclusions of the FSAR accident analyses. Thus, the MDC used as a basis for the most negative feasible, MTC, TS will not change. The reload safety analysis process will include verification that the MDC safety analysis value remains valid. The staff concludes that this verification process for the safety analysis MDC is acceptable.

3.0 SUMMARY

Based on the review discussed above, the staff concludes that the proposed changes to the most negative MTC TS, the MTC surveillance requirement value at or near 300 ppm of boron core condition, and the associated Bases; as well as the suspension of MTC measurements at less than 100 ppm, are acceptable for the following reasons:

(1) The most negative feasible MTC method considered the important factors affecting the MTC and the limits on these factors.

(2) Approved computer codes and methods were used in the analyses.

(3) The MTC measurement at or near 300 ppm of boron will provide assurance that the MTC at EOC, hot full power, all control rods out conditions will be less negative than the safety analysis MTC.

(4) Future reloads for Farley, Units 1 and 2, will be analyzed to confirm the most negative MTC TS at EOC and the MTC surveillance requirement at a core condition of 300 ppm of boron.

(5) The difference between the surveillance requirement at or below 100 ppm of boron and the limiting EOC MTC value conservatively bounds the maximum change in MTC between the 100 ppm boron concentration and the licensed EOC.

(6) Future reloads for Farley, Units 1 and 2, will be analyzed to confirm the applicability of the safety analysis value of the MDC.

4.0 ENVIRONMENTAL CONSIDERATION

These amendments change a requirement with respect to installation or use of a facility component located within the restricted areas as defined in 10 CFR Part 20 and change the surveillance requirements. The staff has determined that these amendments involve no significant increase in the amounts, and no significant change in the types of any effluents that may be released off site, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that these amendments involve no significant hazards consideration, and there has been no public comment on such finding. Accordingly, these amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of these amendments.

5.0 CONCLUSION

The Commission made a proposed determination that this amendment involves no significant hazards consideration which was published in the Federal Register (55 FR 34363) on August 22, 1990, and consulted with the State of Alabama. No public comments or requests for hearing were received, and the State of Alabama did not have any comments.

The staff has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of these amendments will not be inimical to the common defense and security or to the health and safety of the public.

6.0 REFERENCES

1. Letter from W. G. Hairston, III (APCo) to USNRC, dated July 13, 1990.

2. "Safety Evaluation Supporting a More Negative EOL Moderator Temperature Coefficient Technical Specification for the Joseph M. Farley Nuclear Plant Units 1 and 2," WCAP-11953 (proprietary) and WCAP-11954 (non-proprietary), December 1988.

3. "Standard Technical Specifications for Westinghouse Pressurized Water Reactors," NUREG-0452, Revision 4, issued Fall 1981.

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