June 14, 2000

Mr. Ralph Phelps, Chairman
CE Owners Group
Omaha Public Power District
P.O. Box 399
Ft. Calhoun, NE 68023-0399

SUBJECT: ACCEPTANCE FOR REFERENCING OF CE NPSD-911, "ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATIONS END-OF-CYCLE NEGATIVE MTC LIMIT," AND AMENDMENT 1 (TAC NO. MA9036)

Dear Mr. Phelps:

We have concluded our review of CE NPSD-911 and Amendment 1 submitted by Combustion Engineering Nuclear Power (CENP) dated May 1993 and January 1998, respectively. The report is acceptable for referencing in licensing applications for CE plants subject to the limitations specified in the report and in the associated NRC safety evaluation (SE), which is enclosed. The SE defines the basis of acceptance of the report.

We do not intend to repeat our review of the matters described in the report, and found acceptable, when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to matters described in the report.

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," we request that CE publish an accepted version of this topical report within 3 months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed SE between the title page and the abstract. It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, and original report pages that were replaced. The accepted version shall include an "-A" (designating accepted) following the report identification symbol.

Should our criteria or regulations change so that our conclusions as to the acceptability of the topical report are invalidated, the CEOG and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

Sincerely,

/***RA/***

Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 692

Enclosure: Safety Evaluation

cc w/encl:
Mr. Gordon C. Bischoff, Project Director
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Combustion Engineering Nuclear Power
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Mr. Charles B. Brinkman, Manager
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT CE NPSD-911, "ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATIONS END-OF-CYCLE NEGATIVE MTC LIMIT" AND AMENDMENT 1

PROJECT NO. 692

1.0 INTRODUCTION

By letter dated October 6, 1998, (Reference 1) Entergy Operations, Inc. (Entergy) requested changes to the Waterford 3 Technical Specifications (TS) and requested review of the Combustion Engineering Owners Group Topical Report, CE NPSD-911, "Analysis of Moderator Temperature Coefficients in Support of a Change in the TSs End-of-Cycle Negative MTC Limit" dated May 1993, and Amendment 1, dated January 1998. Amendment 1 provided the answers to the NRC request for additional information dated February 26, 1997. Additional information was provided by Entergy in a letter dated March 2, 2000 (Reference 2). In a letter dated April 11, 2000, the Combustion Engineering Owners Group (CEOG) requested issuance of a safety evaluation on CE NPSD-911 so that the methodology may be used by other CEOG member plants (Reference 3). A clarifying letter dated May 12, 2000, was submitted by Westinghouse Electric Company (Reference 4).

The TS provide limitations on the moderator temperature coefficient (MTC) to ensure that the assumptions used in the accident and transient analysis remain valid through each fuel cycle. The requirements to measure the MTC at the beginning-of-cycle (BOC) (one at hot zero power and one at power) and near end-of-cycle (EOC) (i.e., 2/3 expected core burnup) provide confirmation that the measured MTC value is within its limits and will remain in its limits throughout each cycle.

The purpose of Topical Report CE NPSD-911 and Amendment 1 was to provide the justification to support eliminating the need to determine the MTC upon reaching two-thirds of core burnup if the results of the MTC tests required at the beginning-of-cycle are within a tolerance of $\pm 0.16 \times 10^{-4}$ $\Delta k/k/°F$ of the calculated MTC (design value). However, if the results of the first two tests are not within that limit, then performance of the 2/3 cycle surveillance will be required. The reports concluded that if the MTC at the beginning-of-cycle is within $\pm 0.16 \times 10^{-4}$ $\Delta k/k/°F$ of the design value, then the MTC at the end-of-cycle will also be within $\pm 0.16 \times 10^{-4}$ $\Delta k/k/°F$ of the design value.

2.0 EVALUATION

Accurate knowledge of the MTC at end-of-cycle is of prime importance in order to ensure that the most negative MTC will always be conservative with respect to the TS limit. If enough reliance can be placed on the analytical models and on the end of cycle predicted MTC, the surveillance test can be eliminated.

CE NPSD-911 and Amendment 1 used the following approach. Isothermal temperature coefficients (ITC) were used since they are measured quantities. The measured ITC was assumed to represent the true value. The impact of systematic errors in the measurements was reduced by combining the values obtained on several plants by several utilities. The best estimate ITC was then equal to the calculated value plus the bias (as established by the mean of the distribution of differences between measured and calculated values). The same bias and uncertainty is assigned to the MTC. Using the relationship ITC = MTC + FTC and assuming that MTC and FTC (fuel temperature coefficient) are statistically independent, it is conservative to assign the same uncertainty to the MTC and to assume that no additional uncertainty is introduced by the FTC.

The analysis used measured MTC data from several plants and compared that data to the calculated MTC. This was done to evaluate the methodology used in calculating the MTC. The reports concluded that evaluation of the data showed that if the MTC measured at the beginning-of-cycle is within $\pm 0.16 \times 10^{-4}$ $\Delta k/k/^\circ F$ of the calculated MTC, then the near end-of-cycle calculated MTC will be within $\pm 0.16 \times 10^{-4}$ $\Delta k/k/^\circ F$ of the true MTC. Thus, the method would adequately model the MTC for the entire cycle, and the near end-of cycle MTC surveillance would not be not required.

The NRC staff reviewed CE NPSD-911 and Amendment 1. The data base used for the analysis consisted of 105 data points taken from ten different Combustion Engineering plants (2700 MW, 2815 MW, 3400 MW and 3800 MW). The measurements used both the rod insertion and the power trade measurement techniques. For 15 cycles, all three conditions (BOC at hot zero power, near BOC at power, and near EOC at power) were analyzed. A total of 30 near EOC values were analyzed. Of the 105 data points, only one shows a residual deviation that equals the design margin.

ITC predictions were all made at the measured critical conditions so that no adjustments were needed. The test initial conditions (power level, exposure, inlet temperature, soluble boron concentration and lead bank insertion) were simulated, taking into account all thermal-hydraulics and xenon feedbacks. Then, without changing the xenon distribution, a change of $\pm 3^\circ F$ was applied to the inlet temperature, keeping the thermal-hydraulics feedback effects active. The core average temperature was obtained from edited output and the ITC calculated.

The 105 data points were analyzed for normality using the American National Standard Institute Standard Normality Test. The D' Test statistic was 301.39 which implied that the assumption of normality is appropriate based on the percentage points of the D' Test Statistic. The NRC staff reviewed the complete list of all measured and calculated ITCs. Data given consisted of the plants and cycles, the core enrichment and exposure, the operating conditions (PPM soluble boron, power and moderator temperature), the measured and calculated ITC and the difference

(measured minus calculated) in units of pcm/°F (1pcm = $10^{-5}\Delta k/k$). In addition, the staff reviewed the statistical approach taken and determined that it was a straightforward approach and that it was correctly applied. The staff performed spot checks and found no discrepancies.

Since all of the work to support the analysis was performed using the CE methodology and the design margin was established using that methodology, the staff questioned the validity of using other methodologies for the calculations of MTC if it was desired to eliminate the EOC MTC test. It was determined that the approach would be restricted to using the CE methodology, unless further justification was submitted to the NRC for review and approval.

3.0 CONCLUSION

Based on the review as described in Section 2.0, the staff agrees that the approach described in CE NPSD-911 and CE NPSD-911 Amendment 1 is acceptable subject to the following conditions which were part of Amendment 1. A summary of Conditions 1 and 4 was restated in Reference 4 since the response to Question 8 in Reference 2 was confusing.

1. In order to ensure that the moderator temperature coefficient will not exceed the Technical Specification limit with a confidence/tolerance of 95/95 percent, the cycle must be designed, using the CE methodology, such that the best estimate MTC is:

   a. more negative than the BOC Technical Specification limit by the design margin
   b. more positive than the EOC Technical Specification limit by the design margin

2. The design margin is determined to be 1.6 pcm/°F at all times in life.

3. The analysis of the revised data base, including the most recent measured and calculated MTCs, has established that if the measured beginning-of-cycle moderator temperature coefficients are within 1.6 pcm/°F of the best estimate prediction, then it can be assumed that the end-of-cycle coefficient will also be within 1.6 pcm/°F of the prediction and its measurement is not required.

4. The measured data reduction must be based on the current CE methodology as described in the report.

5. If the beginning-of-cycle measurements fail the acceptance criteria of ±1.6 pcm/°F and the discrepancy cannot be resolved, the end-of cycle surveillance test must be performed.

4.0 REFERENCES

1. Letter from C. M. Dugger, Entergy to NRC Document Control Desk, dated October 6, 1998.

2. Letter from C. M. Dugger, Entergy to NRC Document Control Desk, dated March 2, 2000.

3. Letter from Ralph Phelps, Combustion Engineering Owners Group to NRC Document Control Desk, dated April 11, 2000.

4. Letter from Paul Hijeck, Westinghouse Electric Company to NRC Document Control Desk, dated May 12, 2000.

Principal Contributor: M. Chatterton

Date: June 14, 2000