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D.C. COOK UNIT 2, CYCLE 5
SAFETY ANALYSIS REPORT

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EXXON NUCLEAR COMPANY, INC.

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SAFETY ANALYSIS REPORT

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1.0 INTRODUCTION

This report is a supplement to the cycle 5 Safety Analysis Report for D.C. Cook Unit 2. The main report addressed the operating history of the reference cycle, power distribution considerations, control rod reactivity requirements, temperature coefficient considerations, and the control rod ejection accident analysis.

This report presents results of ECCS LOCA, thermal margin, rod bow, and radiological assessment analyses. The ECCS LOCA and plant transient analyses were performed to support operation of the D.C. Cook Unit 2 reactor with 5% of the steam generator tubes plugged. The rod bow analysis was performed because rod bow results are dependent on the plant transient predictions for 5% tube plugging. The radiological assessment was redone using ENC's current radiological assessment methodology, which now includes the generically approved version of RODEX2.

2.0 SUMMARY

The D.C. Cook Unit 2 nuclear plant is scheduled to begin cycle 5 operation in the spring of 1984. The reload (reload batch XN-2) will consist of ninety-two fresh 17x17 fuel assemblies designed by Exxon Nuclear Company. A description of the cycle characteristics as well as the reference cycle are provided in the main cycle 5 Safety Analysis Report(1) along with the fuel description.

In anticipation of steam generator tube degradation, American Electric Power requested Exxon Nuclear to provide the analyses needed to support operation of D.C. Cook Unit 2 with up to 5% of the tubes plugged. The ECCS LOCA and plant transient analyses required to support operation with up to 5% tube plugging, are provided in References 2 and 3, respectively.

For the cycle 4 design, the fuel burnup and plant power were increased. Therefore an assessment was made of the potential radiological consequences of the postulated accidents(4). The NRC had not completed the generic review of RODEX2 which is the Exxon Nuclear fuel performance code, which was used as part of the radiological assessment. The review has now been completed, and the analysis redone using the approved version. The results of reanalyses(5) show that the previous assessment provides bounding predictions.

A rod bow evaluation, required for assembly burnups greater than 28,000 MWD/MTU, was done using the generically approved Exxon Nuclear methodology. The results indicated that there was margin between the DNBR limit and the minimum DNBR even with the calculated penalty for rod bow. Also, the calculations showed that the total peaking uncertainty was within design tolerances. Therefore, there is no impact on the design from rod bow.

3.0 CYCLE DESIGN

The cycle design, reference cycle comparisons, and neutronic characteristics of cycle 5 of D.C. Cook Unit 2 are presented in Reference 1. This report also addresses the control rod reactivity requirements, moderator temperature coefficient considerations, and power distribution. The results of all of these analyses confirm that the cycle 5 design will operate within the technical specification limits for a projected cycle length of 17,900 MWD/MT at a core power of 3411 MWt with 10 ppm soluble boron remaining.

4.0 FUEL DESIGN

A description of the Exxon Nuclear supplied fuel design and design methods is contained in Reference 6. This fuel has been designed to be compatible with the resident fuel and to maintain its mechanical integrity while satisfying the neutronic and thermal hydraulic design requirements.

The creep collapse evaluation in reference 6 was performed using the criterion proposed in the Exxon Nuclear high burnup report (10). This proposed criterion precludes the formation of gaps in the pellet stack, thus precluding creep collapse of the cladding. The prior creep collapse criterion, that the cladding had to be free-standing throughout its design life, is satisfied up to a peak rod exposure of 40,000 MWD/MTU.

Since the previous end-of-life rod internal pressure calculations were completed prior to the approval of RODEX2, a reanalysis was performed to verify that the rod internal pressure remained less than the system pressure. This calculation was redone with the approved version of RODEX2. The maximum predicted end-of-life rod pressure was less than 1600 psia, well under the system pressure of 2250 psia.

5.0 THERMAL HYDRAULIC DESIGN ANALYSIS

The Exxon Nuclear supplied fuel has been designed to be thermal-hydraulically compatible with the co-resident fuel in the D.C. Cook Unit 2 core. This analysis is reported in Reference 7 and is unchanged with the 5% steam generator tube plugging.

6.0 ACCIDENT AND TRANSIENT ANALYSES

6.1 LOCA ECCS ANALYSIS

The loss of coolant ECCS analysis was redone for D.C. Cook Unit 2 assuming a 5% steam generator tube plugging level. A detailed description of the analyses and the results are presented in Reference 2. The report documents operating limits which assure operation of the D.C. Cook Unit 2 reactor is within criteria specified by 10 CFR 50.46 and Appendix K.

6.2 PLANT TRANSIENT ANALYSES

The plant transient analyses for D.C. Cook Unit 2 were redone assuming a 5% steam generator tube plugging level. The primary coolant flow was reduced to reflect increased flow resistance in the steam generators. The steam generator heat transfer area was reduced and the effects of the plugging on the limiting transients were analyzed. A detailed description of the analyses and the results are presented in Reference 3. These results showed that SAFDL's are not violated for the anticipated operational occurrences and that 10 CFR Part 100 radiological limits are satisfied for postulated accidents.

6.3 ROD BOW ANALYSIS

The Exxon Nuclear methodology for computing a rod bow penalty(8) to the departure from nucleate boiling ratio (DNBR) and for computing the effects of rod bow on the total peaking (F_Q^U) uncertainty was being reviewed by the NRC at the time the cycle 4 analysis was presented. Therefore the cycle 4 Safety Evaluation Report (SER) required that the effects of rod bow be assessed for Exxon Nuclear designed fuel with assembly exposures greater than 28,000 MWD/MTU. Since that SER, the Exxon Nuclear methodology was generically approved by the Staff. Using this methodology, the effect of rod bow on the MDNBR for the limiting transient has been reevaluated. The rod bow penalty for the limiting anticipated operational occurrence (AOO) requires the MDNBR to be reduced 13.2% at a peak D.C. Cook Unit 2 assembly exposure of 43,000 MWD/MTU. The approved XNB[9] limit for DNBR is 1.17. Above this limit fuel failures are not predicted and acceptance criteria are satisfied. To satisfy this limit at a peak D.C. Cook Unit 2 assembly exposure of 43,000 MWD/MTU, the MDNBR from the limiting AOO must be greater than 1.35. The plant transient analyses for the D.C. Cook Unit 2 with 5% of the steam generator tubes plugged showed that the limiting transient (slow control rod withdrawal) had an MDNBR above 1.35. Therefore, no operational penalty is required to account for rod bow.

Similarly, the changes in the total peaking uncertainty (F_Q^U) and the total peaking (F_Q) are within the design tolerances. Therefore, no penalty is required.

7.0 ASSESSMENT OF RADIOLOGICAL CONSEQUENCES OF ACCIDENTS

An analysis of the biological doses received from radiological release during accidents involving high exposure fuel was documented in Reference 4 and submitted for cycle 4 operation of D.C. Cook Unit 2. That report demonstrated that the Exxon Nuclear fuel would not violate the 10 CFR 100 off-site radiation dose limits after operating the reactor with increased core power and irradiating the fuel to a batch average exposure of 40,000 MWD/MTU. The isotopic release fractions from the fuel were calculated with the then-current version of the RODEX2 fuel performance code.

Subsequent to that analysis, a revised version of RODEX2 received final generic approval from the NRC. Therefore, the potential doses were reanalyzed using the approved RODEX2 to calculate the release fractions(5). The results of that reanalysis showed the previous assessment to be bounding,i.e., the previous assessment predicted larger potential doses.

8.0 REFERENCES

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