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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 67 TO FACILITY OPERATING LICENSE NO. DPR-74

INDIANA AND MICHIGAN ELECTIC COMPANY

DONALD C. COOK NUCLEAR PLANT UNIT NO. 2

DOCKET NO. 50-316

1.0 Introduction

To support Cycle 5 operation of D. C. Cook 2, the licensee, Indiana and Michigan Electric Company, provided, in references 1 and 2, LOCA analyses which demonstrated conformance to the requirements of 10 CFR 50.46. These analyses were based upon a total peaking factor, F_Q^T, of 2.04 with a nuclear enthalpy rise hot channel factor, $F_{\Delta H}^N$, of 1.415. In reference 3, we found these analyses to be acceptable.

In reference 4, the licensee submitted a requested change to Technical Specification 3.2.3 to allow operation with a $F_{\Delta H}^N$ of 1.55. The increased $F_{\Delta H}^N$ was requested in order to allow continued full power operation of D. C. Cook 2 during Cycle 5. To support the changes in the Technical Specification, the licensee provided revised LOCA analyses, reference 5. This SER presents our evaluation of these submittals.

2.0 Evaluation Model

Prior to Cycle 5 operation of D. C. Cook 2, the licensee provided the LOCA analysis documented in reference 1. That analysis was performed using the revised Exxon Nuclear Company (ENC) ECCS evaluation model. This model is called EXEM/PWR and is documented in reference 6.

During our review of the EXEM/PWR model, we found that most of the model changes proposed were in compliance with Appendix K to 10 CFR 50. However, we concluded that insufficient documentation was provided to substantiate the correction factors employed on the reflood heat transfer coefficients to account for the effect of mixing vanes and local rod peaking. We determined these factors could not be used in the D. C. Cook 2 LOCA analyses.

As a result of the staff's determination, ENC proposed, in reference 7, a revised method to account for local rod peaking effects on the reflood heat transfer coefficients. This revised method, which was developed specifically for application to Cycle 5 operation of D. C Cook 2 was reviewed and found acceptable by the staff. This revised method was incorporated into the evaluation model utilized in the LOCA analysis and documented in reference 2 which supported operation of Cycle 5 for D. C. Cook 2. Our determination that the revised model utilized for D. C. Cook 2 satisfies Appendix K to 10 CFR 50 is documented in reference 3.

Since the LOCA analyses performed prior to Cycle 5 operation of D. C. Cook 2, ENC has proposed a further revision to their EXEM/PWR ECCS evaluation model. This model change is documented in reference 8 and was used for the revised LOCA analysis discussed herein. This model change proposes a method of applying the EXEM/PWR heat transfer correlations to axial power distributions different from the 1.66 chopped cosine axial power distribution used in the FLECHT tests which formed the basis for the EXEM/PWR correlations.

To apply this methodology, adjustments were made in both the REFLEX and TOODEE2 codes. Within the REFLEX code, differences in axial power distribution relative to the FLECHT tests are accounted for by modifying the initial core average values for QMAX and TINIT. These values are used as input to the carryout rate fraction and quench front correlations. The specific methods used to define these parameters are given in reference 8.

The calculated core reflooding rate, carryout rate fraction and quench front propagation from REFLEX are input to the TOODEE2 code for calculating the fuel rod heat transfer coefficients and cladding temperature response. The same approach used to adjust QMAX and TINIT for the REFLEX code is utilized for the TOODEE2 input except that the hot rod values are adjusted. These modified input parameters are then used directly within the EXEM/PWR reflood heat transfer correlations. An equivalent elevation is then used, based upon conserving the integral power between the fuel rod and the FLECHT rod, to apply the calculated heat transfer coefficients. That is, if the FLECHT rod at 8 feet has the same integral power as the fuel rod at 8.5 feet, the heat transfer coefficients calculated at 8 feet for the FLECHT rod are applied at the 8.5 foot elevation on the fuel rod. The specific ENC method utilized to conserve integral power is discussed in reference 8.

To demonstrate the appropriateness of their model, ENC provided benchmarks to the FLECHT skewed power low flooding rate heat transfer tests 11428, 14331 and 16110. These data were obtained from reference 9. The ENC comparisons showed that the proposed method yielded higher cladding temperatures, and hence lower heat transfer coefficients, than observed in the FLECHT tests. Thus, the ENC methodology is conservative.

In addition to evaluating the information provided by ENC, the staff reviewed some of the FLECHT data to assure that the ENC methodology is conservative. Comparisons were made between FLECHT cosine tests 02414 and 03113 and the skewed power shape tests 15305 and 11003 using the proposed ENC method. These comparisons further illustrated the conservatism of the ENC method. Thus, we find the ENC methodology to be acceptable.

In summary, we find the EXEM/PWR ECCS evaluation model, as applied for D. C. Cook 2, Cycle 5 to be wholly in conformance with Appendix K to 10 CFR 50.

3.0 LOCA Analysis

In reference 5, the licensee provided a revised LOCA analysis for Cycle 5 operation of D. C. Cook 2. The analysis was performed using the same input assumptions as those in reference 2, except the nuclear enthalpy rise hot channel factor, $F_{\Delta H}^{N}$, was increased from 1.415 to 1.55. The axial power profile was change to reflect a total peaking factor, F_{Q}^{T}, of 2.04. In addition, the EXEM/PWR methodology of reference 8 was applied for this analysis.

The analysis used the Cycle 5 core configuration, 85% ENC fuel, and was performed for core burnups of 2 MWD/kg, 10 MWD/kg and 47 MWD/kg. The results of the analysis are given on Table 1. As shown, the analysis showed a peak cladding temperatures of 2014°F, a maximum local zirconium metal-water reaction of 4.7%, and core wide maximum metal-water reactions less than 1%.

We have reviewed the analyses provided by the licensee and have concluded that they satisfy the criteria of 10 CFR 50.46 and were performed with an evaluation model wholly in conformance with Appendix K to 10 CFR 50. Thus, we find that use a nuclear enthalpy rise hot channel factor of 1.55 is acceptable for Cycle 5 operation of D. C. Cook 2.

In addition to the analyses performed for Cycle 5, the licensee also provided LOCA analyses assuming a core configuration of 100% ENC fuel. This core configuration is representative of that expected for Cycle 6 and beyond. The results of the LOCA analyses demonstrated that a core configuration of 100% ENC fuel would be capable of meeting the 10 CFR 50.46 limits. However, these analyses were based upon the Cycle 5 ECCS evaluation model. The staff has not yet judged that the Cycle 5 evaluation model is appropriate for future core reloads. Thus, we will require that the licensee provide revised LOCA analyses prior to Cycle 6 operation.

4.0 Technical Specification Change

The current Technical Specification 3.2.3, entitled "Power Distribution Limits, RCS Flowrate and Nuclear Enthalpy Rise Hot Channel Factor," imposes a measured $F_{\Delta H}^{N}$ limit of 1.36 at 100% power. This value is 4% less than the value of 1.415 utilized in the LOCA analysis of reference 2, which was performed to initially support Cycle 5, in order to account for measurement uncertainty on $F_{\Delta H}^{N}$. In addition, the current Technical Specification places an $F_{\Delta H}^{N}$ limit of 1.49 at 100% power in order to protect DNBR events. Operation of Cycle 5 is restricted by the most limiting of the two $F_{\Delta H}^{N}$ limits as a function of power level.

In reference 4, the licensee submitted changes to Technical Specification 3.2.3 to implement the increased $F_{\Delta H}^{N}$ of 1.55 assumed in the LOCA analysis. Allowing for the 4% meaurement uncertainty, this yields an $F_{\Delta H}^{N}$ of 1.49, which is the same as the $F_{\Delta H}^{N}$ limit for DNBR protection for non-LOCA events. The licensee modified the Technical Specification to delete the previous $F_{\Delta H}^{N}$ limits for LOCA considerations as the $F_{\Delta H}^{N}$ limit for non-LOCA events is more restrictive as a function of power level.

We have reviewed the revised Technical Specification 3.2.3 and find it acceptable.

Summary

Based upon the foregoing discussions, we find:

a. The revised LOCA analysis was performed using a model wholly in conformance with Appendix K to 10 CFR 50.

b. The revised analysis shows that continued operation of D. C. Cook 2 Cycle 5 with an $F_{\Delta H}^{N}$ of 1.55 will meet the requirements of 10 CFR 50.46.

c. The licensee has implemented appropriate Technical Specification changes consistent with the revised LOCA analysis.

Therefore, we conclude that the proposed Technical Specification changes are acceptable.

7.0 ENVIRONMENTAL CONSIDERATION

This amendment involves a change in the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that this amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, this amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR Sec 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 this amendment.

8.0 CONCLUSION

We have 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, and (2) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Dated: April 8, 1985

Principal Contributors:

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6.0 References

(1) XN-NF-84-21(P), "Donald C. Cook Unit 2, Cycle 5, 5% Steam Generator Tube Plugging Limiting Break LOCA/ECCS Analysis," Exxon Nuclear Company, Inc., Richland, WA 99352, February 1984.

(2) XN-NF-84-21(P), Revision 1, "Donald C. Cook Unit 2, Cycle 5, 5% Steam Generator Tube Plugging Limiting Break LOCA/ECCS Analysis," Exxon Nuclear Company, Inc., Richland, WA 99352, May 1984.

(3) Memorandum, R. Houston to G. Lainas, "D. C. Cook 2, Cycle 5," June 6, 1984.

(4) Letter, M. P. Alexich (IMECo) to H. R. Denton (NRC), "Application for Unit 2 Technical Specification Changes For Cycle 5," Docket No. 50-316, August 28, 1984.

(5) XN-NF-84-21(P), Revision 2, "Donald C. Cook Unit 2, Cycle 5, 5% Steam Generator Tube Plugging, Limiting Break LOCA/ECCS Analysis," Exxon Nuclear Company, Inc., Richland, WA 99352, July 1984.

(6) XN-NF-82-20(P), Rev. 1, August 1982; Supplement 1, March 1982; and Supplement 2, March 1982, "Exxon Nuclear Company Evaluation Model EXEM/PWR ECCS Model Updates," Exxon Nuclear Company, Inc., Richland, WA 99352.

(7) Letter, J. C. Chandler (ENC) to H. R. Denton (NRC), Subject: Additional Information Regarding Unit 2 Cycle 5 LOCA ECCS Analysis, May 7, 1984.

(8) XN-NF-82-20(P), Rev. 1, Supplement 4, "Exxon Nuclear Company Evaluation Model EXEM/PWR ECCS Model Updates: Adjustments To FLECHT Based Heat Transfer Coefficients," Exxon Nuclear Company Inc., Richland, WA 99352, July 1984.

(9) WCAP-9183, "PWR FLECHT Skewed Profile Low Flooding Rate Test Series Evaluation Report," Westinghouse Nuclear Electric Systems, Pittsburgh, PA, November 1977.

TABLE 1

1.0 DECLG Break Fuel Response Results for Cycle 5

Peak Rod Average Burnup (MWD/kg)	2.0	10.0	47.0
Initial Peak Fuel Average Temperature (°F)	2151	2060	1629
Hot Rod Burst			
• Time (sec)	69.5	70.5	78.5
• Elevation (ft)	7.0	7.0	7.75
• Channel Blockage Fraction	.25	.28	.47
Peak Clad Temperature			
• Time (sec)	287	288	269
• Elevation (ft)	9.63	9.63	9.38
• Temperature (°F)	2007	2014	1993
Zr-Steam Reaction			
• Local Maximum Elevation (ft)	9.63	9.63	9.38
• Local Maximum (%)	4.6	4.7	4.5
• Core Maximum	<1.0	<1.0	<1.0