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

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO EVALUATION OF RESPONSE TO NRC BULLETIN NO. 90-02

COMMONWEALTH EDISON COMPANY

DRESDEN NUCLEAR POWER STATION, UNIT 2

DOCKET NO. 50-237

1.0 INTRODUCTION

The licensee responded to NRC Bulletin No. 90-02, "Loss of Thermal Margin Caused by Channel Box Bow," in a letter dated April 26, 1990, and indicated that 303 channel boxes were being used for a second fuel bundle lifetime in the Dresden Unit 2 reactor core (Reference 1). The response described the number and disposition of these channel boxes in the core, and described the actions taken to assure compliance with the technical specification thermal limits.

The initial NRC staff review of the April 26, 1990 submittal (response to NRC Bulletin 90-02), found the actions described in Attachment B of Reference 1 acceptable since the four bundle array used in the analysis of the channel box bow effect on thermal limits provided an appropriate limiting configuration (Reference 2). This approval only applied to the procedure Dresden Unit 2 took to circumvent the collection and analysis of bow data, with respect to Cycle 12. It did not approve the methodology or sanction the future reuse of used channel boxes. This safety evaluation covers the staff review of the Commonwealth Edison Company strategy for reuse of channel boxes for Cycle 13 and future cycles.

2.0 EVALUATION

2.1 Background - Dresden Unit 2, Cycle 12

Dresden Unit 2 currently has a significant number of reused channel boxes as a result of Commonwealth Edison's previous channel box management strategy. During the Cycle 9 and Cycle 10 refueling outages, fresh reload fuel assemblies received channel boxes with one or two prior cycles of irradiation.

Magnitudes of Channel Box Bow

Channel box exposures were compiled and projected to the end of Cycle 12. Of the 303 reused channels, 194 will exceed 40 GWd/MTU exposure and 28 will surpass 50 GWd/MTU prior to shutdown for refueling scheduled for September 1990. Essentially all of the reused channel boxes, 297 out of 303, were manufactured by Carpenter Technology.

Due to relatively high channel box exposure, the licensee had requested Advanced Nuclear Fuels (ANF) to perform a cycle (Cycle 12) specific analysis for Dresden Unit 2. ANF methodology consisted of assuming a limiting four bundle cell in the core (Reference 3). Bow data based on three channel boxes at approximately 52 GWd/MTU exposure adjacent to a limiting fresh channel box at about 12 GWd/MTU exposure were used. The bow data at this exposure showed very good agreement when compared to inhouse NRC correlated bow data. The bounding channel box bow data used for this configuration was greater than the actual narrow gap width in Dresden Unit 2.

Channel Box Bow Effects on Local Peaking Factors

Channel box bow data was also used to make detailed physics calculations of a single bundle lattice to determine local peaking factors/effects due to channel box bow. These local peaking factors were determined using the computer code CASMO-3G. The limiting bundle (in terms of thermal margin) in the core was assumed to reside next to assemblies contained in channel boxes with high exposure. A conservative set of local power distributions as a function of exposure for the limiting lattice type in the core was subsequently determined and used as input in the thermal margin calculations (Reference 4).

Channel Box Bow Effects on Critical Power Ratio (CPR)

ANF's generic channel box bow methodology statistically accounts for the effects of channel box bow by an adjustment to the Mimimum Critical Power Ratio (MCPR) safety limit; however, an equivalent adjustment to the MCPR operating limit provides the same level of thermal margin protection. The thermal margin reduction was calculated using ANF (Revision 1) thermal hydraulic codes and methods (Reference 5). The critical power ratio was determined from analysis of the base local peaking distributions when the bowed local distributions would result in a bundle CPR dryout. This analysis also simulated the core monitoring code to determine the value of the CPR that the POWERPLEX CMSS could predict that would insure that the dryout does not occur for a bundle next to highly bowed channel boxes. This resulted in a CPR penalty of approximately 0.15. This penalty was offset by known conservatisms in the XN-3 critical heat flux correlation (greater than 0.09). ANF discussed this conservatism with the NRC staff, and submitted documentation to that effect (Reference 6). This conservatism reduced the net CPR penalty to 0.06. This net CPR adjustment was incorporated into the MCPR operating limit for Dresden Unit 2, Cycle 12.

The results of Dresden Unit 2 channel box bow analysis for Cycle 12 are summarized below:

(MCPR Operating Limit)	+	(CPR Bow Penalty)	-	(XN-3 Conservatism)
1.39		0.15		0.09
	=	(New MCPR Operating Limits)		
		1.45		

2.2 Effects of Channel Box Reuse on Thermal Margin - Dresden Unit 2, Cycle 13

The licensee stated in their September 21, 1990 submittal titled, "Dresden Nuclear Power Station Unit 2, Fuel Channel Evaluation for Dresden Unit 2, Cycle 13" (Reference 7), that approximately 50 percent of the reused channel boxes will be discharged from Dresden Unit 2 prior to start of Cycle 13. Specifically, 183 of these fuel assemblies are scheduled for use in Dresden Unit 2, Cycle 13. Also Commonwealth Edison will be placing new channel boxes on 16 of the 183 fuel assemblies; therefore, there will be 167 assemblies with reused channel boxes in Dresden Unit 2, Cycle 13. The 16 fuel assemblies which will receive new channel boxes will be located in a limiting location in the central region of the core. Replacement of these channel boxes will minimize the effect of channel box bow on thermal margins for Dresden Unit 2, Cycle 13 since all other assemblies with reused channels will be loaded into low power core locations, which are located within three rows of the core's periphery. The low assembly power associated with these reused channels will provide a large degree of MCPR operating limit margin in these core locations.

Although fuel assemblies located in low power peripheral regions of the core normally operate with substantial thermal margin, collected data and analysis shows that they are subject to greater channel box bowing because of the flux difference between the interior and exterior sides of the channel box. Analysis by the licensee shows that the greater thermal margin available is sufficient to offset the larger CPR penalty needed for expected channel box bow. Figure A-1 of Reference 7 shows the projected end of Cycle 13 channel box exposure for those locations with reused channel boxes. The maximum projected end of Cycle 13 channel box exposure is 53.8 GMd/MTU in a peripheral location. Figure A-1 also illustrates control blade locations to indicate in which direction the channel boxes will tend to bow. The licensee pointed out that those channel boxes with a water face will tend to bow away from the water face due to the flux gradients across the channel. Therefore, the bow is likely to be restricted by the narrow gap width of 374 mills in Dresden Unit 2. Bowing of a channel box causes an increase in the wide-wide water gap between assemblies which are adjacent to one another on either side of a control blade. For this reason, the assemblies most affected by channel box bow are the assembly with the channel box having the high exposure, and the adjacent assemblies across the wide-wide water gap. For Cycle 13, the assemblies with the reused channel boxes are not limiting due to their low power, as these assemblies are located near the core periphery and are typically on their fourth cycle of irradiation.

Assemblies loaded adjacent to reused channel boxes were evaluated to determine the most limiting location. This evaluation showed that assemblies loaded at Position (13, 4) of Figure A-1 (Reference 7) and the octant symmetric partners of this location are the most limiting of all assemblies affected by the peripheral reused channel boxes. These assemblies are once-burned and are located closest to the core center (relative to all other assemblies which are loaded adjacent to assemblies with reused channel boxes).

Analysis by the licensee indicated that for Cycle 13, Dresden Unit 2 will be operating with substantial margin to the operating limit. The analysis showed that the MCPR margin on the most limiting assemblies which would be affected by the peripheral reused channel boxes have a minimum of 27 percent margin to the operating limit. This minimum, which occurs during the middle of the cycle at peak reactivity is significantly greater than the maximum degradation (4%) due to extreme channel bow as determined by the licensee. Therefore, the reuse of channel boxes as proposed will not have a MCPR safety margin impact.

The licensee conducted in-depth analysis of the effects of excessive channel box bow on the MCPR Safety Limit and the Linear Heat Generation Rate (LHGR). Previous cycle specific sensitivity analyses were carried out for the licensee by Advanced Nuclear Fuel (ANF) using the ANFB methodology. The analyses showed that channel bow magnitudes similar to those projected for Dresden Unit 2, Cycle 13, could result in an increase to the MCPR Safety Limit of approximately 0.08. This is within the XN-3 critical power correlation conservatism of 0.09. Therefore, the potential increase in the MCPR safety limit due to reused channels is bounded by the conservatism of the XN-3 correlation.

The licensee also addressed the issue of the LHGR Safety Limit. Analysis by ANF for the licensee, showed that a sufficient operating margin (at least a factor of two) to the ANF transient design limit exists to ensure that the fuel design safety limits will not be approached during Cycle 13, should an overpower event occur.

MAPLHGR analysis by the licensee showed that those assemblies without the effect of channel box bow bound the MAPLHGR limit of those assemblies adjacent to and with a second lifetime channel. Consequently, operation within MAPLHGR limits for unbowed channels assures that MAPLHGR limits are not exceeded for bowed channel cases.

3.0 CONCLUSION

Based on the above evaluation the NRC staff has concluded that the licensee's Cycle 13 reload core design with used channel boxes and the methods used to account for channel box bow has an acceptable impact on core operating limits in the upcoming cycle (Cycle 13) because the data and methodology provide reasonable assurance that the thermal margin to the CPR safety limit is maintained. The Dresden Unit 2, Cycle 13 submittal has two significant commitments which must be preserved.

(1) Reused fuel channel boxes distribution (current Cycle 13 locations) must not be changed without NRC approval.

(2) All 167 reused channel boxes must be replaced at the end of Cycle 13.

If in future cycles channel box reuse is considered by the licensee, further review and prior approval by the NRC staff will be required.

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4.0 REFERENCES

1. Letter from M. H. Richter, Commonwealth Edison, to NRC, Response to NRC Bulletin 90-02, "Channel Bow Analysis for Dresden 2," April 26, 1990.

2. Letter from NRC to Thomas J. Kovach, Commonwealth Edison Company, June 5, 1990.

3. ANF-524(P), Revision 2, Supplement 1, "Advanced Nuclear Fuels Corporation Critical Power Methodology for Boiling Water Reactors - Methodology for Analysis of Assembly Channel Bowing Effects," November 1989.

4. Studsvik/NFA-86/8, "CASMO-3: A Fuel Assembly Burnup Program (Methodology)," Studsvik Energiteknik AB, Nykoping, Sweden, November 1986.

5. ANF-524(P), Revision 1, "Exxon Nuclear Critical Power Methodology for Boiling Water Reactors," Exxon Nuclear Corporation, November 1983.

6. Letter R. A. Copeland (ANF), to R. C. Jones (USNRC), "Loss of Thermal Margin Caused by Channel Box Bow," April 9, 1990.

7. Letter from M. H. Richter, Commonwealth Edison, to NRC, "Effect of Channel Reuse on Thermal Margins Dresden Unit 2 Cycle 13," dated September 21, 1990.