



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATING TO EVALUATION OF RESPONSE TO NRC BULLETIN NO. 90-02  
WASHINGTON PUBLIC POWER SUPPLY SYSTEM  
WASHINGTON NUCLEAR POWER UNIT 2  
DOCKET NO. 50-397

1.0 BACKGROUND

WNP-2 is a C-lattice boiling water reactor (BWR) and as such, is less susceptible than a D-lattice core to the phenomena of, and effects from, channel box bow. Washington Public Power Supply System (the licensee) is aware of the potential problems associated with channel box bow, and for that reason had embarked on a channel management program since initial operation. The licensee's channel management program is described in the WNP-2 Final Safety Analysis Report (FSAR), Section 4.2.4.4, Amendment 43 and in Reference 1. This channel management program consists of data collection on channel operating history and actual measurement of channel distortion as a function of channel operation. The licensee discontinued channel measurement after measuring all of the channels intended for reuse at WNP-2. The licensee's ultimate goal is to transition away from channel box reuse. The number of reused channel boxes destined to be used in Cycle 11 is 38. This is considerably less than the number (104 channel boxes) used in Cycle 10. Eight channels will be replaced at the end of Cycle 10 because their exposures at the end of Cycle 11 are projected to exceed 50 gigawatt days/metric tonne uranium (GWD/MTU). These channels will be replaced with exposed channels which have been measured and found to meet the criteria established in Reference 2 for allowable distortion.

Beginning with Cycle 7, the licensee began to include the effects of channel box bow in its reload design analyses. The analyses utilized the NRC approved the Advanced Nuclear Fuels (ANF) methodology for determining the Safety Limit Minimum Critical Power Ratio (SLMCPR). The ANF data incorporated in the ANF methodology has been reviewed previously by the NRC staff and included WNP-2 measured data (Reactor D in this data base). Analysis of the data indicated that WNP-2 is observing less channel box bow due in part to the fact that WNP-2 is a C-lattice BWR. This data extends to an exposure of 49 GWD/MTU.

This safety evaluation discusses the staff review of the licensee's strategy for reuse of channel boxes in the upcoming Cycle 11 operation.



## 2.0 EVALUATION

### 2.1 Channel Box Characterization

Channel box selection for reuse at WNP-2 is conducted by establishing an accept/reject criteria based on "Distortion Allowance." Discharged channel boxes were measured in the WNP-2 channel box measuring machine and the total maximum distortion (channel bow plus channel bulge) due to reactor operation was determined. The licensee has shown that total channel box distortion will vary along the channel with the maximum distortion value usually located near the middle of the channel.

The channel box bow methodology utilized by the licensee and approved by the NRC staff (Reference 2) takes into account channel box present and future distortion allowance and nominal design clearance. Used channel boxes are qualified for reuse if their measured distortion (from nominal) is less than a predetermined distortion allowance.

The licensee defines "Nominal Design Clearance" as the nominal clearance between the channel box and the potential interference (in this case the control blade and/or the local power range monitor [LPRM]) as defined by the design drawings of the reactor core.

The calculated future distortion (CFD) is defined as the total distortion (channel bow plus channel bulge) as determined by the WNP-2 channel box model. The model is based upon the expected future irradiation path of the fuel assembly upon which the channel box will be placed. The licensee pointed out that typically the future irradiation path is assumed to be five cycles at the interior of the core and one cycle on the periphery. The amount of channel box bulge for the interior and the periphery is determined from the channel box bow model, assuming operation at 100 percent power. The model sums the results of the five cycles at the interior and one at the periphery to obtain a total expected bulge.

Similarly, channel box bow data is obtained from figures/plots generated by the channel box model for both the interior and periphery locations and again at assumed 100 percent power. The total expected channel box bow and bulge are then summed to obtain the total expected channel box distortion.

With the nominal design clearance known from design drawings and calculated future distortion determined from the WNP-2 channel box bow model, the licensee is able to determine a distortion allowance value(s) for clearance of both the control blade and the LPRM for any given cycle. Channel boxes with measured total distortion less than the control blade and the LPRM distortion allowances are qualified for reuse.

### 2.2 Estimated Exposure and Maximum Calculated Channel Box Bow

In previous submittals, the licensee pointed out that the magnitude and direction of channel box distortion (channel bow plus channel bulge) is directly dependent upon the location history of the channel boxes. The channel boxes that will have the largest estimated maximum exposure at the end

of Cycle 11 are channel boxes designated 71938 and 73444. These channel boxes are expected to have a total accumulated exposure at the end of Cycle 11 of approximately 47.5 GWD/MTU and 44.1 GWD/MTU respectively. The licensee's analytical model predicts a maximum calculated channel box bow for these channel boxes to be less than 105 mils. The exposures and channel box distortion for the remaining reused channels in WNP-2 are less (in some cases much less) than the values stated above. The calculated total distortion for all reused channels in the Cycle 11 core is small enough to avoid interference with both control blades and in-core instrumentation.

### 2.3 Channel Box Measurement

The licensee has measured bow data on channel boxes out to exposures of approximately 27 GWD/MTU. The measured (maximum) data was compared to calculated data generated by the channel box distortion model. The calculated values are required to be conservative relative to measured data. The licensee will only reuse measured channel boxes.

### 2.4 Channel Box Bow Effects on the MCPR Limits

The licensee indicated that it will take into account the channel box bow effects on the minimum critical power ratio (MCPR) operating limit by modifying (recalculating) the SLMCPR, maintaining the same delta CPR. The WNP-2 SLMCPR was established through statistical considerations of measurement and calculation uncertainties associated with the thermal hydraulics state of the reactor using design basis radial, axial, and local power distributions and considering fuel channel box bow (Reference 4). The effects of the channel box bow will increase the WNP-2 Cycle 11 MCPR safety limit by about 0.02.

### 3.0 CONCLUSION

Based on the above evaluation, the NRC staff has concluded that the licensee's Cycle 11 reload design with reused channel boxes and the methods used to account for the channel box impact on the core operating limits is acceptable. The data and the methodology used provide reasonable assurance that the thermal margin to the MCPR safety limit is maintained.

The NRC staff has also determined that the licensee should evaluate future reuse of channel boxes under 10 CFR 50.59. In accordance with this regulation, prior NRC review and approval is only necessary if the reuse involves an unreviewed safety question or a change to the WNP-2 technical specifications.

### 4.0 REFERENCES

1. Letter, J. V. Parrish, Supply System, to NRC, "Nuclear Plant No. 2, Operating License NPF-21, Response to NRC Bulletin No. 90-02: Loss of Thermal Margin Caused by Channel Box Bow," December 1, 1994.

2. Letter, G. C. Sorensen, Supply System, to NRC, "Final Response to NRC Bulletin No. 90-02: Loss of Thermal Margin Caused by Channel Box Bow," September 28, 1990.
3. Letter, NRC to G. C. Sorensen, Supply System, "Evaluation of Response to NRC Bulletin No. 90-02; Loss of Thermal Margin Caused by Channel Box Bow," April 22, 1991.
4. ANF-524(P)(A), "Advanced Nuclear Fuel Corporation Critical Power Methodology for Boiling Water Reactors," Revision 2, Supplements 1 and 2, November 1990.

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Date: April 25, 1995

