UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO EVALUATING THE RESPONSE TO NRC BULLETIN NO. 90-02

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

NUCLEAR PROJECT NO. 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 (WPPSS) is aware of the potential problems associated with channel box bow, and for that reason WPPSS had embarked on a channel management program since initial operation. 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's ultimate goal is to transition away from channel box reuse. The number of reused channel boxes destined to be used in cycle 10 is 129 less than that used in cycle 9.

Beginning with cycle 7, the licensee began to include the effects of channel box bow in their reload design analyses. The analyses utilized the NRC approved Advanced Nuclear Fuels Company (ANFC) methodology for determining the Safety Limit Critical Power Ratio (SLCPR). The ANFC data incorporated in the ANFC methodology has been reviewed previously by the NRC 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. This data extends to an exposure of 49 GWD/MTU.

This safety evaluation covers the staff review of the WPPSS strategy for re-use of channel boxes in the upcoming cycle 10.

2.0 EVALUATION

2.1 Characterizing Channel Boxes

Channel boxes selection for reuse at WNP-2 is conducted by establishing an accept/reject criteria based on "distortion allowance". Discharged channel boxes are measured in the WNP-2 channel box measuring machine and the total maximum distortion (channel bow plus channel bulge) due to reactor operation is 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 NRC approved channel box bow methodology utilized by the licensee, 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 + 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 10 are channel boxes designated 71848 and 61550. These channel boxes are expected to have a total accumulated exposure at the end of cycle 10 of approximately 49.3 GWD/MTU.

The Supply System 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.

Subsequent to the March 29, 1994, submittal in support of the cycle 10 reload, the Supply System conducted a visual inspection of the serial numbers of those

channel boxes being removed and reused on selected fuel assemblies. During this inspection, it was discovered that in the spring of 1990 (in support of cycle 6 reload), channel box #71806 was installed on fuel assembly #UD5034 instead of being stored in the spent fuel pool as planned. During this same outage, while discharging reused channels 71908 and 70158, the licensee discovered that these channels were swapped. Evaluations conducted by WNP-2 showed that the exposures of these channels at the end of cycle 9 was below 50 GWd/MTU.

In their March 29, 1994, submittal, WNP-2 reported that channel 71806 would be used on assembly UD5064. In fact, it is channel 71771 that will be reused on assembly UD5064, located in row, column position 6,10 of the core. The projected exposure for this channel is 28,482 MWd/MTU. WNP-2 has submitted revised data (tables) reflecting these corrections, and additional visual inspections of all the reused channels that are part of the cycle 10 reload were performed to ensure that there were no other incorrectly installed channels. The inspections confirmed that all reused channels were installed on the correct fuel assemblies for the up coming cycle 10.

2.3 Channel Box Measurement

The Supply System has measured bow data on channel boxes out to exposures of approximately 27 GWD/MTU. Their measured (maximum) data was compared to calculated data generated by the channel box distortion model. The calculated values were found to be conservative relative to measured data.

2.4 Channel Box Bow Effects on 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 calculations 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. The effects of the channel box bow will increase the WNP-2 cycle 10 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 10 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 used and the methodology provide reasonable assurance that the thermal margin to the MCPR safety limit is maintained. If in future cycles channel box reuse is continued, further review and prior approval by the NRC staff will be required.

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